524 Rec'd PCT/PTO 20 SEP 1999

Form PTO-1390 U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DE/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: 41-303-3

U.S APPLICATION NO. (If known, see 37 CFR 1.5): 09/381526

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/CH98/00109	March 19, 1998 (21.03.98)	March 21, 1997 (21.03.97)

TITLE OF INVENTION: METHOD FOR ANCHORING JOINING ELEMENTS IN MATERIAL HAVING PORES OR CAVITIES AND JOINING ELEMENTS FOR ANCHORING

APPLICANT(S) FOR DE/EO/US: Marcel Aeschlimann, Elmar Mock, Laurent Torriani & Heinz Koester

Applicant herewith submits to the United States Designated/Elected Office (DE/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
    ☒ A SECOND or SUBSEQUENT preliminary amendment.
14. ☒ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information:
    Letter to the Official draftsperson

CERTIFICATE OF EXPRESS MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as Express Mail, Post Office to Addressee, in an envelope addressed to Assistant Commissioner for Patents, Washington, D.C. 20231, on September 20, 1999

by Walter C. Farley

9-20-99
Date

Express Mail Receipt No.:

EJ640084566US

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U.S. APPLICATION NO. (If known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NO
09/381526	PCT/CH98/00109	41-303-3

17. ☒ The following fees are submitted:	CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1) - (5)):		
Search Report has been prepared by the EPO or JPO ..... $ 840.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) ..... $ 670.00		
No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) ..... $ 760.00		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... $ 970.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) ..... $ 96.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 840	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☒ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$ 130	

Claims	Number Filed	Number Extra	Rate		
Total Claims	25 - 20	4	x $18	$ 90	
Independent Claims	4 - 3	1	x $78	$ 78	
Multiple dependent claim(s) (if applicable)			+ $260	$ 0	
			TOTAL OF ABOVE CALCULATIONS =	$ 1138	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				$	
			SUBTOTAL =	$ 1138	
Processing fee of $130 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f))			+	$ 0	
			TOTAL NATIONAL FEE =	$ 1138	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property			+	$ 0	
			TOTAL FEES ENCLOSED =	$ 1138	
			Amount to be: Refunded	$	
			Charged	$	

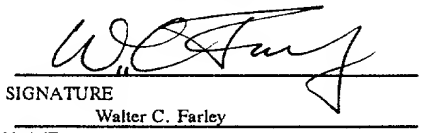
a. ☒ A check in the amount of $ 1,138.00 to cover the above fees is enclosed.

b. ☐ Please charge my deposit Account No. _____ in the amount of $ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☐ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment, to Deposit Account No. _____. A duplicate copy of this sheet is enclosed.

Note: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:
CUSTOMER NO. 000805
Walter C. Farley
P.O. Box 329
Harpswell, ME 04079
Tel: (207) 833-6793
Fax: (207) 833-7831



SIGNATURE

Walter C. Farley
NAME

22,624
REGISTRATION NUMBER

Attorney's Docket 41-303-3

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:

Marcel Aeschlimann et al

PCT/CH98/00109

International filing date
19 March 1998

For: METHOD FOR ANCHORING JOINING ELEMENTS IN MATERIAL HAVING POROUS OR CAVITIES AND JOINING ELEMENTS FOR ANCHORING

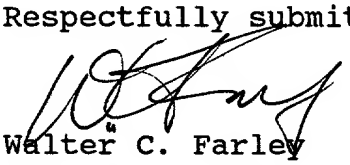
LETTER TO THE OFFICIAL DRAFTSPERSON

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

Submitted herewith is a proposed drawing correction to add a reference numeral inadvertently omitted in the parent PCT application.

Respectfully submitted,



Walter C. Farley
Reg. No. 22,624,
Attorney for Applicant(s)

P. O. Box 329
Harpswell, ME 04079
Tel: (207) 833-6793
Fax: (207) 833-7831

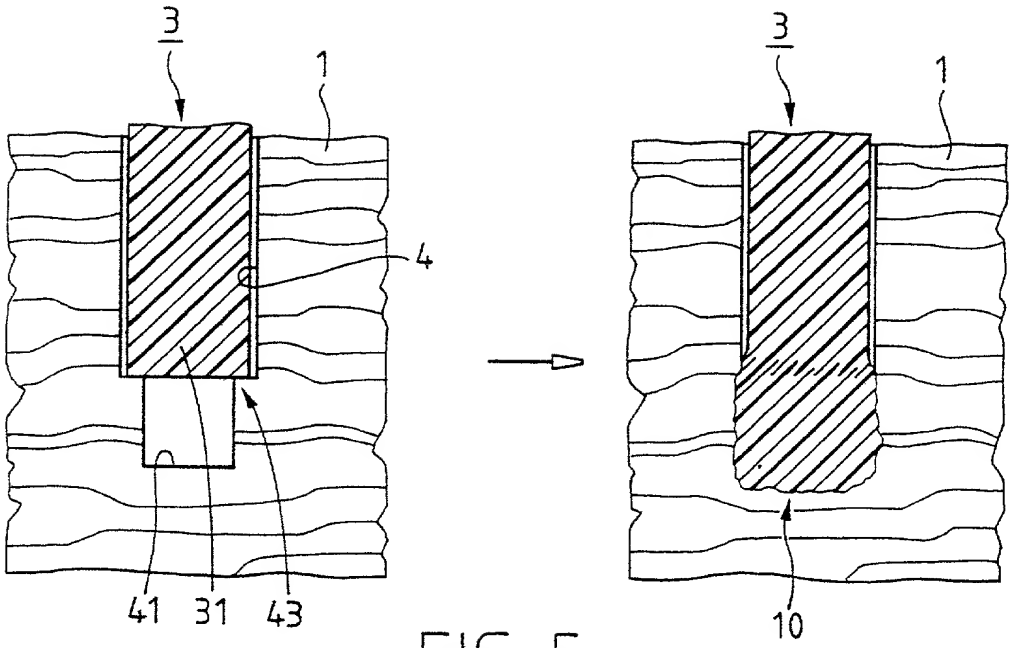


FIG. 5

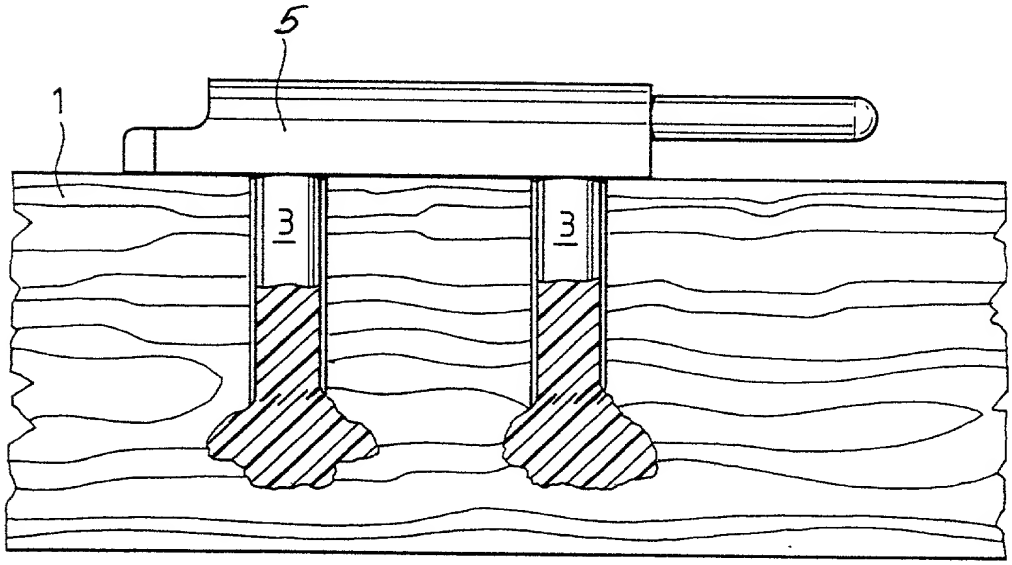


FIG. 6

Attorney's Docket 41-303-3

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:

Marcel Aeschlimann et al

PCT/CH98/00109

International filing date
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For: METHOD FOR ANCHORING JOINING ELEMENTS IN MATERIAL HAVING PORES OR CAVITIES AND JOINING ELEMENTS FOR ANCHORING

FIRST PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

Before calculating the filing fee, please amend the claims of the above-identified application as follows to remove multiple dependency.

Claim 6:

line 2, change "one of the claims 1 to" to -- claim --.

Claim 7:

line 1, change "one of the claims 1 to" to -- claim --.

Claim 8:

line 1, change "one of the claims 1 to" to -- claim --.

Claim 9:

line 1, change "one of the claims 1 to" to -- claim --.

Claim 10:

line 1, change "one of the claims 1 to" to -- claim --.

Claim 11:

line 1, change "one of the claims 1 to" to -- claim --.

Claim 12:

lines 1 and 2, delete "for use in a method according to one of the claims 1 to 11, said joining element".

Claim 15:

line 1, change "one of the claims 12 to " to -- claim --.

Claim 17:

line 1, change "one of the claims 12 to" to -- claim --.

Claim 18:

line 1, change "one of the claims 12 to" to -- claim --.

Claim 19:

line 1, change "one of the claims 12 to" to -- claim --.

Claim 20:

line 1, change "one of the claims 12 to" to -- claim --.

Cancel claims 21 and 22.

Respectfully submitted,

Walter C. Farley
Reg. No. 22,624
Attorney for Applicant(s)

P.O. Box 329
Harpswell, ME 04079
(207) 833-6793

Attorney's Docket 41-303-3

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:

Marcel Aeschlimann et al

PCT/CH98/00109

International filing date
19 March 1998

For: METHOD FOR ANCHORING JOINING ELEMENTS IN MATERIAL HAVING PORES OR CAVITIES AND JOINING ELEMENTS FOR ANCHORING

SECOND PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

Before examination, please amend the above-identified application as follows.

IN THE SPECIFICATION:

Please substitute the Substitute Specification submitted herewith for the original translation of the parent PCT application.

IN THE CLAIMS:

Please cancel claims 1-20 (claims 21 and 22 having been previously canceled) and add the following new claims.

-- 23. A method for anchoring a joining element (3, 3.1,

...3.4) in a part (1) comprising a porous material having cavities or in which cavities can be produced by pressure, the joining element including a thermoplastic material at least at the location of a preselected anchoring point, the method comprising the steps of

forming a bore in the part (1), the bore having an inner closed end and being matched to the shape and dimensions of the joining element so that the joining element can be inserted into a first position in the bore with substantially no force,

positioning the joining element in the bore in the first position,

applying pressure to force the bore into a second, deeper position in the bore, the pressure being applied substantially along a central axis of the bore and producing an increase of pressure at the preselected anchoring point (31, 33) between the joining element and walls of the bore,

during the application of pressure, applying energy to the joining element to cause the thermoplastic to plasticize at the preselected anchoring point, the pressure causing the plasticized thermoplastic material to flow into pores or cavities of the part (1) adjacent the bore, thereby forming a macroscopic anchoring connection

between the part and the joining element. --

-- 24. A method according to claim 23 wherein the preselected anchoring point is adjacent the closed end of the bore, and wherein, in the first position of the joining element, an inner end thereof is adjacent the closed end of the bore. --

-- 25. A method according to claim 23 including providing the joining element and the bore with matching reductions in diameter forming a shoulder in the bore and a shoulder on the joining element, wherein the preselected anchoring point is adjacent the closed end of the bore, and wherein, in the first position of the joining element, the joining element shoulder rests on the bore shoulder. --

-- 26. A method according to claim 23 including joining a second part (2) made of a porous material to the first-mentioned part (1) with the joining element, wherein the joining element is a joining pin having a reduction in diameter intermediate the ends thereof forming a shoulder, wherein the step of forming a bore includes forming a portion of the bore through the second part and

into the first part to an inner closed end, the bore in the second part having a reduction in diameter matching the reduction in diameter of the joining pin, and the step of positioning includes inserting the joining pin into the first ans second parts with the shoulders of the joining pin and bore in contact to define the first position, the contacting shoulders forming a second macroscopic connection between the second part and the joining element. --

-- 27. A method according to claim 23 including joining a second part (2) made of a porous material to the first-mentioned part (1) with the joining element, wherein the joining element is a joining pin, wherein the step of forming a bore includes forming a portion of the bore through the second part and into the first part to an inner closed end, and wherein the joining pin has an enlarged head portion on an outer end thereof. --

-- 28. A method according to claim 23 including fixedly attaching the joining element to the second part. --

-- 29. A method according to claim 28 wherein the step of

fixedly attaching is performed before positioning the joining element in the bore. --

-- 30. A method according to claim 23 wherein the step of applying energy includes ultrasonically exciting the joining element to cause the thermoplastic to plasticize. --

-- 31. A method according to claim 23 wherein the joining element consists entirely of thermoplastic material capable of being plasticized in the region of an anchoring point at a lower temperature than the remainder of the element, and wherein the step of applying energy includes heating the joining element. --

-- 32. A method according to claim 23 including incorporating metal particles in the thermoplastic material at least in the region of the preselected anchoring point, and wherein the step of applying energy includes inductively heating the joining element. --

-- 33. A method according to claim 23 wherein the part (1,

2.2) comprises wood or a wood-like material. --

-- 34. A method according to claim 23 wherein the part comprises at least one of sandstone, porous ceramic, burnt brick or concrete. --

-- 35. A method for anchoring a joining element (3, 3.1, ...3.4) in a structural component having a cavity or in which a cavity can be produced by pressure, the joining element including a thermoplastic material at least at the location of a preselected anchoring point, the method comprising the steps of

forming a bore in the component (1) with the bore having an inner closed end so that the joining element can be inserted into a first position in the bore with substantially no force,

positioning the joining element in the bore in the first position,

applying pressure to force the bore into a second, position in the bore, the pressure being applied substantially along a central axis of the bore and producing an increase of pressure at the preselected anchoring point between the joining element and the

bore,

during the application of pressure, applying energy to the joining element to cause the thermoplastic material to plasticize at the preselected anchoring point, the pressure causing the plasticized thermoplastic material to flow into one or more cavities of the component (1), thereby forming a macroscopic anchoring connection between the component and the joining element. --

-- 36. A joining element for attachment in a bore having a closed inner end in a part comprising a porous material, said joining element comprising

a body shaped and dimensioned to be inserted to a first position into the blind bore with substantially no force, said body having

a thermoplastic material at a first preselected anchoring point at said closed inner end of said bore in said first position, and

a thermoplastic material at a second anchoring point in said bore and spaced from said first anchoring point,

said thermoplastic material at said first and second anchoring locations being plasticizable by the application of energy and pressure to form macroscopic anchoring connections with said part in said bore. --

-- 37. A joining element for attachment in a bore having a closed inner end in a part comprising a porous material, said joining element comprising

a body shaped and dimensioned to be inserted to a first position into the blind bore with substantially no force, said body having

a thermoplastic material at a first preselected anchoring point at said closed inner end of said bore in said first position, and

an enlarged portion forming a head on said anchoring element, said head being at an outside end of said bore in said first position,

said thermoplastic material at said first anchoring location being plasticizable by the application of energy and pressure to form a macroscopic anchoring connection with said part in said bore. --

-- 38. A joining element according to claim 37 wherein said element is formed as an elongated pin and includes a second anchoring point spaced from said first anchoring point and lying within said bore in said first position. --

-- 39. A joining element according to claim 38 and including an internally threaded opening for receiving an attachment. --

-- 40. A joining element according to claim 38 consisting entirely of thermoplastic material. --

-- 41. A joining element according to claim 40 wherein said thermoplastic material at said anchoring points is plasticizable at a lower temperature at said anchoring points than at other portions of said joining element. --

-- 42. A joining element according to claim 38 comprising

thermosetting material having portion of thermoplastic material at said preselected anchoring points. --

-- 43. A joining element according to claim 38 wherein said thermoplastic material at said anchoring points includes metal particles incorporated in said thermoplastic material. --

-- 44. A joining element according to claim 38 wherein an inner end of said element is shaped with a point. --

-- 45. A joining element according to claim 38 wherein an inner end of said element is flat or concave. --

-- 46. A joining element according to claim 37 wherein said thermoplastic material selected from the group consisting of polyamide, polycarbonate, polyester carbonate, acrylonitrile-butadiene-styrene, styrene-acrylonitrile, polymethylmethacrylate, polyvinyl chloride, polyethylene, polypropylene and polystyrene. --

-- 47. A joining element according to claim 36 adapted for joining wooden parts of shutters or window frames. --

REMARKS

A substitute specification is submitted herewith. Because of the rather large number of minor corrections necessary to place the translation of the parent PCT application in good, readable form for U.S. examination, and because of the clerical time which would be required to enter such amendments, it is requested that this substitute specification be entered to replace the original literal translation which is also submitted herewith.

A marked-up copy of the translation showing the changes is also submitted. No new matter has been entered.

The originally submitted claims have been revised to place them in better condition for examination.

Respectfully submitted,

Walter C. Farley
Reg. No. 22,624,
Attorney for Applicant(s)

P. O. Box 329
Harpswell, ME 04079
Tel: (207) 833-6793
Fax: (207) 833-7831

METHOD FOR ANCHORING JOINING ELEMENTS IN MATERIAL HAVING PORES OR CAVITIES AND JOINING ELEMENTS FOR ANCHORING

Inventors: Marcel Aeschlimann
Elmar Mock
Laurent Torriani
Heinz Koester

FIELD OF THE INVENTION

This invention relates to a method of anchoring joining elements in a material having pores or cavities, particularly in wood or wood-like materials (e.g., chip-boards). The invention also relates to joining elements for use in the method. The joining elements anchored according to the method of the invention are more particularly used for producing constructions comprising different parts or for attaching fittings.

BACKGROUND OF THE INVENTION

According to the prior art, parts made from wood or woody materials are interconnected, e.g., using joining elements in the form of nails or screws which are driven through one of the parts to be joined into the other part to be joined. Screws and nails are generally made from metal and have a head in a surface area of one of the parts to be joined and are at least frictionally or positively anchored in another of the parts to be joined. These pin-like joining elements constitute in wooden structures metallic, often corrosive, foreign bodies which can be prejudicial to working after the joining of the parts and which represent heat transfer bridges in the finished structures.

It is also known to join parts made from fibrous materials, including wood and wood-like materials, to parts made from thermoplastics. The thermoplastic is plasticized at its surface facing the fibrous material part and the two surfaces are pressed onto one another. The plastic is thereby applied in plasticized form to the surface of the fibrous material or it is plasticized in the final position, e.g., by ultrasonic excitation. In all of these methods, a joint is formed at the interface between the plastic and the fibrous material in the sense of a microscopic interlocking in that the plasticized plastics material is pressed into surface irregularities of the fibrous material. Such methods are, e.g., described in FR-2 455 502, FR 1 495 999, DE-38 28 340 or EP-269476. According to WO-96/01 377, the plastics part can also be a dowel, which joins together two wooden parts. The same principle forms the basis for known methods for joining parts made from wood or wood-like materials, in which between the parts to be joined is placed a layer of a thermoplastics material, e.g., a paint layer, and the parts are then pressed together and subjected to ultrasonic action (JP 52 127 937, WO 96/01377).

In all the aforementioned methods, synthetic material and fibrous material are joined together by surface adhesion resulting from microscopic interlocking and this occurs in the same way in conventional bonding or adhesion processes. The above methods have many of the same disadvantages as bonding methods, particularly their sensitivity to moisture and thermal stresses in which the two joined-together surfaces expand to varying degrees and considerable shear forces arise which weaken or even destroy the joint.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a method for anchoring joining elements, e.g., joining pins, in parts made

from a material having pores or cavities, particularly in parts made from wood or wood-like materials, this method being based on the aforementioned methods for joining plastic/synthetic material and wooden parts, but in which the disadvantages thereof are at least reduced, i.e., in particular provides anchors, which are more stable under thermal and/or moisture stresses and loads. The method is simple, but still adaptable in specific ways to joining elements with different functions and to different material types. The method is also performable with known means and tools and at a limited cost.

According to the method of the invention, an anchoring plasticized synthetic material is not merely pressed into surface irregularities as in the known methods, but instead into pores or cavities within the part in which the joining element is to be anchored, so that a macroscopic anchor is formed. This macroscopic anchor is based on the penetration of the plasticized synthetic material into microscopic pores of the material and to the formation of a type of composite comprising the original porous material and the synthetic material which has penetrated it or to macroscopic interlocking, which results from the fact that the plasticized synthetic material is pressed into macroscopic cavities.

According to the method of the invention in which the joining element is to be anchored, an opening with a closed end, e.g., a bore (blind hole) is formed and then the joining element is positioned in the bore, the joining element being wholly or partly made from a thermoplastic material.

The shapes of the bore and the joining element are so matched to one another that the joining element, without force expenditure, can be introduced into the bore up to a first position and that, if it is driven with the aid of a pressing force parallel to the bore axis from the first position toward the closed end of the bore into a second, final position,

pressure builds up at at least one predetermined anchoring point between the joining element and the bore wall, but no pressure arises at other points.

Simultaneously with the pressing in of the joining element from its first to its second position in the bore, or immediately prior thereto, energy is supplied to the joining element in such a way that the plastics material is locally plasticized at the aforementioned, predetermined anchoring points where the pressure is concentrated. This planned, local plasticizing can, e.g., be achieved by providing at least one of the following characteristics:

- the joining element is entirely made from a thermoplastic material or at least in areas of the predetermined anchoring points has at least surface areas made from a thermoplastic material and the joining element is subjected to ultrasonic or some other appropriate vibration action for supplying energy, so that at the pressure concentration points (predetermined anchoring points) the greatest friction and therefore the maximum heat is produced and consequently the thermoplastic material is locally plasticized (related to joining methods such as ultrasonic, friction, vibration or orbital welding);

- the joining element, in areas of the predetermined anchoring points, has at least surface areas of a thermoplastic material which are plasticizable at a lower temperature than the remaining materials of the joining element and in that the joining element is heated by heat supply;

- the joining element, in areas of the predetermined

anchoring points, has at least surface areas of a thermoplastic material, in which are incorporated metal particles and so that the joining element can be inductively heated.

In the inside of the joining element which, in the closed bore, is directed toward the closed end of he bore, the joining element has at least one first, predetermined anchoring point. On its outside end, i.e., on the end projecting from the bore or positioned in the bore opening, the joining element has a thickening serving as a head or a means for attaching a further part or has further anchoring points spaced toward the outside from the first anchoring point. It is also conceivable to have pin-like joining elements with several predetermined anchoring points.

While the joining element is pressed in the second, final position in the bore and energy is simultaneously supplied thereto, at the predetermined anchoring points where a high pressure occurs between the joining element and the bore wall, the joining element material is plasticized and as a result of the pressure at these points is pressed into the bore wall or into pores or cavities in the material which is adjacent to the bore, whereas it remains unchanged at other points.

To be sure that the plasticized synthetic material is pressed by the pressure produced at the anchoring points into the bore wall, the bore wall must be porous or have openings or cavities, or the bore wall must be created in such a way that, as a result of the pressure, formed pores or cavities are produced into which the plasticized material can be pressed. Porous materials suitable for anchors according to the method of the invention are in particular wood or wood-like materials, but also sandstone, ceramic materials, burnt brick or concrete, etc. Cavities suitable for producing anchors according to the

invention open substantially transversely to the bore axis and are in particular found in lightweight structural components.

The attainable depth of the anchoring of a synthetic material in a porous material is dependent on its structure (e.g., for wood on the density of the wood fibers), but also on the pressure applied and the locally available plasticized material quantity. As will be shown hereinafter, in solid wood, e.g., anchoring depths of 1 to 4 cm are readily attainable.

The desirable depth of the anchor of the synthetic material in a porous material is dependent on the loadability of the material and can be controlled by the quantity of material to be pressed in and/or by the applied pressing force level. The shape of the anchor can be substantially controlled by suitable matching of the bore shape and the joining element shape. Thus, using the method according to the invention it is possible to produce anchors which are specifically adapted to the character of the material (e.g., wood type, orientation of the graining or density gradient relative to the orientation of the bore, etc.) in which the anchoring is to be accomplished and to the function and loading to be absorbed by the joining element.

The most advantageous bore and joining element shapes for a specific application, as well as the pressing force level and the quantity of energy to be supplied to the joining element are to be established experimentally in each specific case.

BRIEF DESCRIPTION OF THE DRAWINGS

The inventive method for anchoring joining elements in a part made from a porous material, particularly wood or a wood-like material, or a material having suitable cavities and different types of joining elements, is described in greater detail hereinafter with reference to the attached drawings, wherein:

Fig. 1 is a diagram showing successive steps in one embodiment of a method for anchoring a joining pin with a head in one wooden part for joining two wooden parts;

Fig. 2 is a diagram showing successive steps in another embodiment of a method for anchoring a joining pin in two wooden parts to be joined;

Figs. 3, 4 and 5 are diagrams showing steps of forming three embodiments of the anchoring point in areas of the closed bore end;

Fig. 6 is a side elevation of a fitting, which is attached to a wooden part using a plurality of joining pins anchored in the wooden part.

Fig. 7 is a sectional side elevation of a method for anchoring a joining element which has an internal thread for attaching further parts; and

Fig. 8 is a sectional side elevation of an anchor according to the invention anchored in a lightweight component with cavities.

In all of the drawings, the joining elements, bores and anchors are shown in section along the bore axis.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 1 shows a first embodiment of the inventive method which involves anchoring a pin-like joining element 3.1 with a head 32 in a first, wooden part 1 for joining first part 1 to a second part 2.1, which is, e.g., also made from wood.

In the vicinity of its inner end, joining pin 3.1 has a predetermined, first anchoring point 31 and at its outer end has a head 32. Bore 4.1 passes entirely through part 2.1 and has, in part 1, a closed end 41, the total length of bore 4.1 being less deep than the length of joining pin 3.1. At the open end of bore 4.1 is, e.g., a widened depression for countersinking head 32. The cross-section of bore 4.1 is so matched to the cross-section of the joining pin 1 that, without force expenditure, the pin can be introduced into the bore up to closed end 41 thereof. This is the first position of joining pin 3.1 in bore 4.1.

From the first position, joining pin 3.1 is pressed further into bore 4.1 with a pressing force F oriented substantially parallel to the bore axis. The only point at which the pressing force F gives rise to pressure between joining pin 3.1 and the wall of the bore 4.1 is the area of closed bore end 41. If, in the above-described manner, by supplying energy to the joining pin it is ensured that during pressing in the material of the joining pin is only plasticized at this point, only at this point is there anchoring 10 of the joining pin in the part 1 to be joined.

In the drawing, anchoring location 10 is shown as a synthetic material area, but in fact is constituted by an intimate mixture of wood fibers and synthetic material, which can be likened to a composite material and which can, e.g., be of pinewood, whose graining is oriented parallel to the bore axis where it has a depth of up to 2 cm.

The length of joining pin 3.1, the depth of bore 4.1, the magnitude of force F and the quantity of energy to be supplied are so matched to one another that the anchor fulfils the desired strength conditions and that the two parts are firmly fixed together between joining pin head 32 and anchoring point 10.

Pin 3.1 of Fig. 1 is anchored in part 1 by the anchoring point 10, which is only possible in a part made from a porous

material, particularly wood or a wood-like material, or, if the bore wall material has suitable cavities in the vicinity of the anchoring point or if the pressure exerted on the joining pin produces such openings in the bore wall.

Part 2.1 can also be made from wood or some other, non-porous material (metal, plastic). As shown in Fig. 1, the head 32 can be a component of the joining pin. However, the head can also be placed on the joining pin after producing the anchor, e.g., can be screwed into a thread provided in the joining pin. The head 32 can be in any random form and can, e.g., also represent a fitting with a specific function.

An advantage of joining two parts in the manner shown in Fig. 1 compared with other joining methods, in which plasticized materials are used as joining materials, is that in all cases it is possible to prevent plasticized material being pressed into the gap between the parts 1 and 2.1 to be joined, resulting in the pressing apart thereof. This is prevented by the feature that, in the region of such a gap, no pressure is built up and the material of the joining pin is not plasticized in that region.

If the energy to be supplied to the joining pin is supplied in the form of ultrasonic waves, in the manner shown, joining pin 3.1 must be made from a thermoplastic material in the area of its inner end to be positioned, as shown on the closed bore end 41. The remainder of the pin can be made from the same material or a different material.

If the energy to be supplied to joining pin 3.1 is supplied in the form of heat, in the vicinity of the anchoring point it is constituted by a plastics material which is plasticizable at a lower temperature than the material from which the joining pin is made in other areas. It is also conceivable in such a case for the joining pin to have a "core" of a heat conducting material, e.g., metal, by means of which core the heat to be supplied to

the joining pin can be conducted toward the anchoring point.

If the energy to be supplied to the joining pin is supplied inductively, the thermoplastic material of the predetermined anchoring point 31 contains incorporated metal particles.

Fig. 2 shows a further embodiment of the inventive method using an anchor of a pin-like joining element (joining pin 3.2) in two parts 1 and 2.2 to be joined together and which are, e.g., of wood, joining pin 3.2 being anchored in both parts 1 and 2.2 (anchoring points 10 and 20).

Like joining pin 3.1 of Fig. 1, joining pin 3.2 has a predetermined, first anchoring point 31 at its inner end to be inserted in the bore. It also has a predetermined, second anchoring point 33, which is in the form of a step-like cross-sectional reduction and on the pin is positioned where it is located in the second part 2.2 to be joined.

Bore 4.2 has a cross-sectional reduction 42 corresponding to the cross-sectional reduction on joining pin 3.2 and on it rests the joining pin in its first position. If joining pin 3.2 is pressed by pressing force F more deeply into the bore 4.2, pressure builds up not only in the vicinity of closed end 41 of the bore 4.2, but also in the area of cross-sectional reduction 42, is pressed through the plastics material plasticized at this point into the wall of the bore 4.2 and consequently forms a second anchor point 20.

Bores 4.1 and 4.2 of Figs. 1 and 2 advantageously have a circular cross-section. Joining pins 3.1 and 3.2 can also be circular. However, they can also have some other cross-section fitting into the corresponding bore. For example, in the vicinity of its smaller cross-section, joining pin 3.2 can be circular and in the area of its larger cross-section can have an angular cross-section (e.g. square) with only the areas of the edges resting on the step 42.

In both Figs. I and 2 closed end 41 of the bore is shown

flat and the joining pin in its first position rests with a flat face in the bore. With such a shaping of the bore and joining pin, on pressing in the pin, a substantially uniform pressure builds up over the entire face. The plasticized material is mainly driven into the wood parallel to the longitudinal axis of the joining pin, so that the cross-section of anchoring point 10 is only slightly larger than the cross-section of the joining pin.

Such a construction of the predetermined, first anchoring point is advantageous for applications in which, in the vicinity of the first anchor 10, the wood grain is oriented parallel to the bore axis and the wood of part 1 splits in the case of a limited displacement. Roughly the same effect is obtainable with a pin end tapered to a point, which in its first position rests on a roughly identically tapering bore end.

Figs 3 to 5 show further embodiments advantageous for specific applications of predetermined, first anchoring points 31 on, e.g., pin-like joining elements 3 and cooperating, closed ends 41 of bores 4, which particularly in the case of ultrasonic application, leads to different anchor points 10.

Fig. 3 shows two embodiments of inner ends of a joining pin 3 which is placed in a closed end of a bore 4. In both cases, the pin end is pointed, specifically more sharply than the bore end. As a result the pressure arising when pressing the joining pin 3 into the bore 4 is centrally concentrated, so that the material is, to an even greater extent, pressed parallel to the pin axis into the part 1, so that also here the resulting anchor point 10 extends more in the axial direction than at right angles thereto. The strength of such an anchor is more particularly due to an enlargement of the shear-loaded surfaces in the wood.

Fig. 4 shows one end of a pin 3 having a concave shape. When pressing this pin into a bore with a flat or pointed, closed end, the pressure mainly builds up at radial positions, which gives

rise to an anchor 10, which extends to a greater extent transversely to the pin axis. Such an anchoring is more particularly suitable for a part 1 where the grain is at right angles to the pin axis, or for an anchor in a chipboard, whose surface is at right angles to the pin axis. The strength of such an anchor results more particularly from the interlocking obtained between the wooden part and the joining pin.

Fig. 5 shows another embodiment of the predetermined, first anchor point 31 on a joining pin 3 and a corresponding bore end 41. It is a first anchor point having substantially the same construction as the second anchoring point of Fig. 2. Bore 4 has a step-like cross-sectional reduction 43, on which is mounted the pin in its first position. When this joining pin is pressed into the bore, more particularly a pressure is built up radially in the vicinity of the bore end and the plasticized material is pressed into the wood more particularly transversely to the pin axis.

Fig. 6 shows a part 5 made from a random material, which is fixed to a part 1 using pin-like joining elements 3 which are anchored in part 1 which is, e.g., made from wood and in accordance with the method of the invention. Part 5 is a fitting (e.g. a hinge part), e.g., made from plastic. Two joining pins 3 are formed onto part 5 or are joined thereto in some other appropriate way and are driven in the described way into bores of part 1 and anchored therein. Here again, as mentioned in conjunction with Fig. 1 concerning a joining pin head, part 5 can have a random shape and, even after producing the anchor, can be appropriately mounted on joining pin or pins 3.

Fig. 7 shows the production of a connection of a wooden part 1 with a fitting part 6, e.g., made from metal, by means of an inventive anchor of a joining element 3.3 in part 1 and the attachment of fitting part 6 to the anchored joining element 3.3. Joining element 3.3 has a two-step, first anchoring point 31 and

is introduced into a bore 4.3 with a step-like, narrowing base. On pressing the joining element into the bore and during the simultaneous plasticizing of the anchoring point 31, bore 4.3 and joining element 3.3 act as explained in conjunction with Fig. 4. A mating "two-step" anchor 10 is formed.

Joining element 3.3 of Fig. 7 has at its outside, facing the predetermined anchoring point, as the means for fixing a further part, an internal thread 34, into which is screwed fitting part 6 after anchoring the joining element 3.3 in part 1.

Fig. 8 shows the result of a further embodiment of the inventive method, namely an anchor of a joining element 3.4 in a part 1, which is a lightweight constructional component with cavities 11. The closed bore necessary for the method according to the invention and into which is introduced the joining element 3.4. is in this case a through-bore 4.4 through one of the outer layers 1.1 of part 1. This through-bore 4.4 is closed by a further element, e.g., by an inner layer 1.2 or optionally by the facing, outer layer 1.3, in such a way that between through-bore 4.4 and the element closing it opens a cavity area 11.1 extending substantially at right angles to the bore axis or is produced by the pressure of joining element 3.4 on the bore-closing element, e.g., by a corresponding deformation of inner layer 1.2.

Joining element 3.4 is inserted in bore 4.4 and is positioned by the bore-closing element (e.g. inner layer 1.2). Joining element 3.4 is then pressed against the bore-closing element and simultaneously the plastics material is plasticized in the area of this element and is pressed into the cavity area 11.1, existing or produced between the outer layer 1.1 and the bore-closing element, so that a macroscopic anchor 10 is obtained.

As has been stated, the method according to Fig. 8 is particularly suitable for light-weight construction applications where, in place of solid material, use is made of thin, board-

like material carried by a support structure (indicated by the two laths 20). Outer layers 1.1 and 1.3 are, e.g., thin, solid wood boards or coated chipboards. The element closing bore 4.4 can, e.g., be a plastic or metal inner layer 1.2 extending from a lath 20 to a neighboring lath 20 or over the entire surface of the first layer, or can be a differently shaped element locally and specifically integrated for this purpose into cavity 11.

Joining element 3.4 according to Fig. 8 is, e.g., suitable for attaching fittings to lightweight structural components.

Thermoplastic materials for use in joining elements advantageously have a high mechanical strength, particularly a high tensile strength and a high modulus of elasticity. Polyamides, polycarbonates or polyester carbonates are particularly suitable. For increasing the strength, the plastics material of a joining element can, e.g., also contain glass or carbon fibers. Further thermoplastics materials suitable for use as joining elements are acrylonitrile butadiene-styrene, styrene-acrylonitrile, polymethylmethacrylate, polyvinyl chloride, polyethylene, polypropylene and polystyrene.

A joining pin for joining two wooden parts, as shown in Fig. 2, e.g., has the form shown in Fig. 2 and is made entirely from acrylonitrile butadiene-styrene. It has a smaller portion with a circular cross-section of a diameter of 8 mm and a larger portion having a circular cross-section with a diameter of 10 mm. It is 60 mm long and is centrally provided with the cross-sectional reduction. The mating bore is 40 mm deep and has the step positioned to correspond to the cross-sectional reduction of the pin at a height of 30 mm. The pin is inserted in the bore and is pressed into it for 5 sec. with a pressing force of 2000 N and ultrasonic excitation with an amplitude of approximately 44 μm. Upon completion of the assembly, the outer pin end is flush with the wood surface.

ABSTRACT OF THE DISCLOSURE

A joining pin (3.2) with which two parts (1 and 2) made from a porous material, particularly wood or a wood-like material, are to be joined together, is anchored in the porous material at predetermined anchoring points (31, 33). For this purpose, a bore (4.2) with a closed inner end (41) is made in the parts (1 and 2). The shape of this bore (4.2) is so matched to the joining pin (3.2) that it can be introduced substantially without force expenditure into the bore and is positionable in a first position. At least one predetermined anchoring point (31, 33) between the joining pin (3.2) and the wall of the bore (4.2) is formed when pressure is built up by pressing the joining pin (3.2) with a pressing force (F) more deeply into the bore to a second position. Energy is supplied in a planned manner to the joining pin (3.2) so that at the predetermined anchoring points (31, 33) the thermoplastic material of the joining pin (3.2) is plasticized. The locally plasticized plastic material is pressed by the local pressure into the porous material of the parts and forms local, macroscopic anchors (10, 20). The joining pin (3.2) is, e.g., made entirely from a thermoplastic material and the energy for plasticizing is supplied thereto by ultrasonic vibration.

METHOD FOR ANCHORING JOINING ELEMENTS IN A MATERIAL HAVING PORES OR CAVITIES, AS WELL AS JOINING ELEMENTS FOR ANCHORING

Inventors: Marcel Aeschlimann
Elmar Mock
Laurent Torriani
Heinz Koester

FIELD OF THE INVENTION

The invention relates to a method ~~according to the preamble of claim 1. The method is used for~~ of anchoring joining elements in a material having pores or cavities, particularly in wood or woodlike materials (e.g. chipboards). The invention also relates to joining elements for use in the method. The joining elements anchored according to the method of the invention are more particularly used for producing constructions ~~consti-tuted by~~ comprising different parts or for ~~fixing~~ attaching fittings.

BACKGROUND OF THE INVENTION

According to the prior art, parts made from wood or woody materials are interconnected, e.g., using joining elements in the form of nails or screws, ~~in that they~~ which are driven through one of the parts to be joined into the other part to be joined. Screws and nails are generally made from metal and have ~~a~~ a head in ~~a~~ surface areas of one of the parts to be joined ~~a head~~ and are at least frictionally or positively anchored in another of the parts to be joined. These pin-like joining elements constitute in wooden structures metallic, often corrosive, foreign bodies, which can be prejudicial to working after the joining of the parts and which represent heat transfer bridges in the finished structures.

It is also known to join parts made from fibrous materials, including wood and woodlike materials, to parts made from thermoplastics. ~~in that~~ The thermoplastic is plasticized at its surface facing the fibrous material part and the two surfaces are pressed onto one another. The plastic is thereby applied in plasticized form to the surface of the fibrous material or it is plasticized in the final position, e.g., by ultrasonic excitation. In all of these methods, a joint is formed at the interface between the plastic and the fibrous material in the sense of a microscopic ~~self-closure~~ interlocking in that the plasticized plastics material is pressed into surface ~~unevennesses~~ irregularities of the fibrous material. Such methods are, e.g., described in FR-2455502, FR-1495999, DE-3828340 or EP-269476. According to WO-96/01377, the plastics part can also be a dowel, which joins together two wooden parts. The same principle forms the basis for known methods for joining parts made from wood or woodlike materials, in which between the parts to be joined is placed a layer of a thermoplastics material, e.g., a paint layer, and the parts are then pressed together and subject to ultrasonic action

(JP-52127937, WO-96/01377).

In all the aforementioned methods, synthetic material and fibrous material are joined together by surface adhesion resulting from microscopic ~~self-closure~~ interlocking and this occurs in the same way in conventional bonding or adhesion processes. The above methods have many of the same disadvantages as bonding methods, particularly their sensitivity to moisture and thermal stresses, in which the two joined-together surfaces expand to varying ~~extents~~ degrees and considerable shear forces arise, which weaken or even destroy the joint.

SUMMARY OF THE INVENTION

An object ~~The problem~~ of the present invention is to provide a method for anchoring joining elements, e.g., joining pins, in parts made from a material having pores or cavities, particularly in parts made from wood or woodlike materials, ~~said~~ this method being based on the aforementioned methods for joining plastic/synthetic material and wooden parts, but in which the disadvantages thereof are at least reduced, i.e., in particular provides anchor~~ings~~s, which are more stable under thermal and/or moisture stresses and loads. The method ~~must be~~ is simple, but still adaptable in specific ~~manner~~ ways to joining elements with different functions and to different material types. The method ~~must~~ is also ~~be~~ performable with known means and tools and at a limited cost.

~~This problem is solved by the method defined in the claims.~~

According to the method of the invention, ~~for~~ an anchoring plasticized synthetic material is not ~~only~~ merely pressed into surface ~~unevennesses~~ irregularities as in the known methods, but instead into pores or cavities within the part in which the joining element is to be anchored, so that a macroscopic anchor~~ing~~ is formed. This macroscopic anchor~~ing~~ is based on the penetration of the plasticized synthetic material into microscopic pores of the material and to the formation of a type of composite comprising the original porous material and the synthetic material which has penetrated it or to macroscopic ~~self-closure~~ interlocking, which results from the fact that the plasticized synthetic material is pressed into macroscopic cavities.

According to the method of the invention ~~in the part~~ in which the joining

element is to be anchored, an opening with a closed end, e.g., a bore (blind hole) is formed and then ~~in said bore is positioned~~ the joining element is positioned in the bore, the joining element being ~~which is~~ wholly or partly made from a thermoplastic material.

The shapes of the bore and the joining element are so matched to one another that the joining element, without force expenditure, can be introduced into the bore up to a first position and that, if it is driven with the aid of a pressing force parallel to the bore axis from ~~said~~ the first position towards the closed end of the bore into a second, final position, pressure builds up at at least one predetermined anchoring point between the joining element and the bore wall, ~~whereas~~ but no pressure arises at other points.

Simultaneously with the pressing in of the joining element from its first ~~in~~to its second position in the bore, or immediately prior thereto, energy is supplied to the joining element in such a way that the plastics material is locally plasticized at the aforementioned, predetermined anchoring points where the pressure is concentrated. ~~Such a~~ This planned, local plasticizing can, e.g., be achieved ~~in that:~~ by providing at least one of the following characteristics:

- the joining element is entirely made from a thermoplastic material or at least in areas of the predetermined anchoring points has at least surface areas made from a thermoplastic material and ~~in that such a~~ the joining element is subject~~ed~~ to ultrasonic or some other appropriate vibration action for ~~the~~ supply~~ing of~~ energy, so that at the pressure concentration points (predetermined anchoring points) the greatest friction and therefore the maximum heat is produced and consequently the thermoplastic material is locally plasticized (related to joining methods such as ultrasonic, friction, vibration or orbital welding);

- ~~in that~~ the joining element, in areas of the predetermined anchoring points, has at least surface areas of a thermoplastic material which ~~is~~ are plasticizable at a lower temperature than the remaining materials of the joining element and in that ~~such a~~ the joining element is heated by heat supply;

- ~~in that~~ the joining element, in areas of the predetermined anchoring

points, has at least surface areas of a thermoplastic material, in which are incorporated metal particles and ~~in~~ so that ~~such a~~ the joining element ~~is~~ can be inductively heated.

~~On its~~ In the of the joining element inside, which, in the closed bore, is directed towards the closed end of the bore, the joining element has at least one first, predetermined anchoring point. On its opposite outside, i.e., on the side projecting from the bore or positioned in the bore opening, the joining element has a thickening serving as a head or a means for ~~fixing~~ attaching a further part or has further anchoring points spaced, toward the outside from the first anchoring point, ~~towards the outside~~. It is also conceivable to have pin-like joining elements with several predetermined anchoring points.

While ~~t~~ the joining element is pressed in the second, final position in the bore and energy is simultaneously supplied thereto, at the predetermined anchoring points where a high pressure occurs between the joining element and the bore wall, the joining element material is plasticized and as a result of the pressure at these points is pressed into the bore wall or into pores or cavities in the material, which is adjacent to the bore, whereas it remains unchanged at other points.

To ~~en~~ be sure that the plasticized synthetic material is pressed by the pressure produced at the anchoring points into the bore wall, ~~it~~ the bore wall must ~~have a~~ be ~~porosity~~ porous or have openings or cavities, or the bore wall must be created in such a way that, as a result of the pressure, formed pores or cavities are produced ~~in~~ into which the plasticized material can be pressed. Porous materials suitable for anchor~~ings~~s according to the method of the invention are in particular wood or wood-like materials, but also sandstone, ceramic materials, burnt brick or concrete, etc. Cavities suitable for producing anchor~~ings~~s according to the invention open substantially transversely to the bore axis and are in particular found in lightweight structural components.

The attainable depth of the anchoring of a synthetic material in a porous material is dependent on its structure (e.g. for wood on the density of the wood fib~~re~~ers), but also on the pressure applied and the locally available plasticized material quantity. As will be shown hereinafter, in solid wood

e.g., anchoring depths of 1 to 4 cm are readily attainable.

The desirable depth of the anchor~~ing~~ of the synthetic material in a porous material is dependent on the loadability of the material and can be controlled ~~via~~ by the quantity of material to be pressed in and/or ~~via~~ by the applied pressing force level. The shape of the anchor~~ing~~ can be substantially controlled by ~~a corresponding~~ suitable matching of the bore shape and the joining element shape. Thus, using the method according to the invention it is possible to produce anchor~~ings~~s, which are specifically adapted to the character of the material (e.g., wood type, orientation of the graining or density gradient relative to the orientation of the bore, etc.) in which the anchoring is to be ~~produced~~ accomplished and to the function and loading to be absorbed by the joining element.

The most advantageous bore and joining element shapes for a specific application, as well as the pressing force level and the quantity of energy to be supplied to the joining element are to be established experimentally in each specific case.

BRIEF DESCRIPTION OF THE DRAWINGS

The inventive method for anchoring joining elements in a part made from a porous material, particularly wood or a woodlike material, or a material having suitable cavities and different types of joining elements, ~~are~~ is described in greater detail hereinafter with reference ~~relative~~ to the attached drawings, wherein ~~show~~:

Fig. 1 is a diagram showing successive steps in one embodiment of a ~~A specific~~ method ~~variant~~ for anchoring a joining pin with a head in one wooden part for joining two wooden parts;

Fig. 2 is a diagram showing successive steps in another embodiment of a ~~Another exemplified~~ method ~~variant~~ for anchoring a joining pin in two wooden parts to be joined;

Figs. 3, ~~to~~ 4 and 5 are diagrams showing steps of forming three ~~Three exemplified~~ embodiments of the anchoring point in areas of the closed bore end;

Fig. 6 is a side elevation ~~An example~~ of a fitting, which is ~~fixed with the aid of~~ attached to a wooden part using a plurality of joining pins anchored in the ~~a~~ wooden part. ~~to said part.~~

Fig. 7 is a sectional side elevation of a ~~Another exemplified~~ method ~~variant~~ for anchoring a joining element, which has an internal thread for ~~fixing~~ attaching further parts; and

Fig. 8 is a sectional side elevation ~~An example~~ of an anchor~~ing~~ according to the invention anchored in a lightweight component with cavities.

In all of the drawings, the joining elements, bores and anchor~~ings~~s are shown in section along the bore axis.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 1 shows ~~as the first, exemplified variant~~ a embodiment of the inventive method which involves ~~an~~ anchoring of ~~a~~ pin-like joining element 3.1 with a head 32 ~~(joining pin 3.1)~~ in a first, wooden part 1 for joining ~~said~~ first part 1 to a second part 2.1, which is, e.g., also made from wood.

In the vicinity of its inner end, ~~the~~ joining pin 3.1 has a predetermined, first anchoring point 31 and at its outer end has a head 32. ~~The~~ Bore 4.1 ~~which~~ passes entirely through ~~the~~ part 2.1 and has, in part 1, a closed end 41, ~~is~~ the total length of bore 4.1 being less deep than the length of joining pin 3.1. ~~is long and has~~ At ~~its~~ the open end of bore 4.1 is, e.g., a widened depression for countersinking ~~the~~ head 32. The cross-section of ~~the~~ bore 4.1 is so matched to the cross-section of the joining pin 3.1 that, without force expenditure, the pin can be introduced into the bore up to ~~the~~ closed end 41 thereof. This is the first position of ~~the~~ joining pin 3.1 in ~~the~~ bore 4.1.

From the first position, ~~the~~ joining pin 3.1 is pressed further into ~~the~~ bore 4.1 with a pressing force F oriented substantially parallel to the bore axis. The only point at which the pressing force F gives rise to ~~a~~ pressure between ~~the~~ joining pin 3.1 and the wall of the bore 4.1 is the area of ~~the~~ closed bore end 41. If, in the above-described manner, by supplying energy to the joining pin it is ensured that during pressing in the material of the joining pin is only plasticized at this point, only at

this point is there ~~an~~ anchoring 10 of the joining pin in the part 1 to be joined.

In the drawing, ~~this~~ anchoring location 10 is shown as a synthetic material area, but in fact is constituted by an intimate mixture of wood fibres and synthetic material, which can be likened to a composite material and which can, e.g., be of pinewood, whose graining is oriented parallel to the bore axis, where it has a depth of up to 2 cm.

The length of ~~the~~ joining pin 3.1, the depth of ~~the~~ bore 4.1, the magnitude of force F and the quantity of energy to be supplied are so matched to one another that the anchor~~ing~~ fulfils the desired strength conditions and that the two parts are firmly fixed together between ~~the~~ joining pin head 32 and ~~the~~ anchoring 10.

~~The joining~~ Pin 3.1 of Fig. 1 is anchored in ~~the~~ part 1 by the anchoring point 10, which is only possible in a part made from a porous material, particularly wood or a woodlike material, or, if the bore wall material has suitable cavities in the vicinity of the anchoring point or if the pressure exerted on the joining pin produces such openings in the bore wall.

Part 2.1 can also be made from wood or some other, non-porous material (metal, plastic). As shown in Fig. 1, the head 32 can be a component of the joining pin. However, the head can also be placed on the joining pin after producing the anchor~~ing~~, e.g., can be screwed into a thread provided in the joining pin. The head 32 can be in any random form and can, e.g., also represent a fitting with a specific function.

An advantage of joining two parts in the manner shown in Fig. 1 compared with other joining methods, in which plasticized materials are used as joining materials, is that in all cases it is possible to prevent plasticized material being pressed into the gap between the parts 1 and 2.1 to be joined, resulting in the pressing apart thereof. This is prevented ~~in~~ by the feature that, in the ~~area~~ region of such a gap, no pressure is built up and the material of the joining pin is not plasticized in ~~said area~~ that region.

If the energy to be supplied to the joining pin is supplied in the form of ultrasonic waves, in the manner shown, ~~the~~ joining pin 3.1 must be made from a thermoplastic material in the area of its inner end to be positioned, as shown, on the closed bore end 41. The remainder of the pin can be made from the same material or a different material.

If the energy to be supplied to ~~the~~ joining pin 3.1 is supplied in the form of heat, in the vicinity of the anchoring point it is constituted by a plastics material, which is plasticizable at a lower temperature than the material from which the joining pin is made in other areas. It is also conceivable in such a case for the joining pin to have a "core" of a heat conducting material, e.g., metal, by means of which core the heat to be supplied to the joining pin can be conducted ~~against~~ toward the anchoring point.

If the energy to be supplied to the joining pin is supplied inductively, the thermoplastic material of the predetermined anchoring point 31 contains incorporated metal particles.

Fig. 2 shows ~~as~~ a further ~~exemplified variant~~ embodiment of the inventive method ~~an~~ using an anchor~~ing~~ of a pin-like joining element (joining pin 3.2) in two parts 1 and 2.2 to be joined together and which are, e.g., of wood, ~~the~~ joining pin 3.2 being anchored in both parts 1 and 2.2 (anchoring points 10 and 20).

Like ~~the~~ joining pin 3.1 of Fig. 1, ~~the~~ joining pin 3.2 has a predetermined, first anchoring point 31 at its inner end to be inserted in the bore. It also has a predetermined, second anchoring point 33, which is in the form of a step-like cross-sectional reduction and on the pin is positioned where it is located in the second part 2.2 to be joined.

~~The~~ Bore 4.2 has a cross-sectional reduction 42 corresponding to the cross-sectional reduction on ~~the~~ joining pin 3.2 and on it rests the joining pin in its first position. If the joining pin 3.2 is pressed by ~~the~~ pressing force F more deeply into the bore 4.2, pressure builds up not only in the vicinity of ~~the~~ closed end 41 of the bore 4.2, but also in the area of ~~the~~ cross-sectional reduction 42, is pressed through the plastics material plasticized at this point into the wall of the bore 4.2 and consequently

forms a second anchoring point 20.

The bores 4.1 and 4.2 of Figs. 1 and 2 advantageously have a circular cross-section. The joining pins 3.1 and 3.2 can also be circular. However, they can also have some other cross-section fitting into the corresponding bore. For example, in the vicinity of its smaller cross-section, the joining pin 3.2 can be circular and in the area of its larger cross-section can have an angular cross-section (e.g. square) or with only the areas of the edges resting on the step 42.

In both Figs. 1 and 2 the closed end 41 of the bore is shown flat and the joining pin in its first position rests with a flat face in the bore. With such a shaping of the bore and joining pin, on pressing in the pin, a substantially uniform pressure builds up over the entire face. The plasticized material is mainly driven into the wood parallel to the longitudinal axis of the joining pin, so that the cross-section of the anchoring 10 is only slightly larger than the cross-section of the joining pin.

Such a construction of the predetermined, first anchoring point is advantageous for applications in which, in the vicinity of the first anchoring 10, the wood graining is oriented parallel to the bore axis and the wood of part 1 splits in the case of a limited displacement. Roughly the same effect is obtainable with a pin end tapered to a point, which in its first position rests on a roughly identically tapering bore end.

Figs. 3 to 5 show further embodiments advantageous for specific applications of predetermined, first anchoring points 31 on, e.g., pin-like joining elements 3 and cooperating, closed ends 41 of bores 4, which particularly in the case of ultrasonic application, leads to different anchoring points 10.

Fig. 3 shows embodiments of inner ends of a joining pin 3, which is placed in a closed end of a bore 4. In both cases, the pin end is pointed, and specifically more sharply than the bore end. As a result the pressure arising when pressing the joining pin 3 into the bore 4 is centrally concentrated, so that the material is, to an even greater extent, pressed parallel to the pin axis into the part 1, so that also here the resulting anchoring point

10 extends more in the axial direction than at right angles thereto. The strength of such an anchoring is more particularly due to an enlargement of the shear-loaded surfaces in the wood.

Fig. 4 shows one end of a pin 3 having a concave shape. When pressing this pin into a bore with a flat or pointed, closed end, the pressure mainly builds up at radial positions, which gives rise to an anchoring 10, which extends to a greater extent transversely to the pin axis. Such an anchoring is more particularly suitable for a part 1, where the graining is at right angles to the pin axis, or for an anchoring in a chipboard, whose surface is at right angles to the pin axis. The strength of such an anchoring results more particularly from the interlocking obtained between the wooden part and the joining pin.

Fig. 5 shows another embodiment of the predetermined, first anchoring point 31 on a joining pin 3 and a corresponding bore end 41. It is a first anchoring point having substantially the same construction as the second anchoring point of Fig. 2. Bore 4 has a step-like cross-sectional reduction 43, on which is mounted the pin in its first position. When this joining pin is pressed into the bore, more particularly a pressure is built up radially in the vicinity of the bore end and the plasticized material is pressed into the wood, more particularly transversely to the pin axis.

Fig. 6 shows a part 5 made from a random material, which is fixed to a part 1 using pin-like joining elements 3, which are anchored in part 1, which is, e.g., made from wood and in accordance with the method of the invention. The part 5 is a fitting (e.g. a hinge part), e.g., made from plastic. The two joining pins 3 are formed onto the part 5 or are joined thereto in some other appropriate way and are driven in the described way into bores of part 1 and anchored therein. Here again, as mentioned in conjunction with Fig. 1 concerning a joining pin head, the part 5 can have a random shape and, even after producing the anchoring, can be appropriately mounted on the joining pin or pins 3.

Fig. 7 shows the production of a connection of a wooden part 1 with a fitting part 6, e.g., made from metal, by means of an inventive anchoring of

attachment
a joining element 3.3 in part 1 and the ~~fixing~~ of ~~the~~ fitting part 6 to the anchored joining element 3.3. ~~The~~ Joining element 3.3 has a two-step, first anchoring point 31 and is introduced into a bore 4.3 with a step-like, narrowing base. On pressing the joining element into the bore and during the simultaneous plasticizing of the anchoring point 31, bore 4.3 and joining element 3.3 act as explained in conjunction with Fig. 4. A ~~corres-~~ mating
~~ponding~~ "two-step" anchor~~ing~~ 10 is formed.

~~The~~ Joining element 3.3 of Fig. 7 has at its outside, facing the predetermined anchoring point, as the means for fixing a further part, an internal thread 34, into which is screwed ~~the~~ fitting part 6 after anchoring the joining element 3.3 in part 1.

Fig. 8 shows the result of a further, ~~exemplified~~ embodiment of the inventive method, namely an anchor~~ing~~ of a joining element 3.4 in a part 1, which is a lightweight constructional component with cavities 11. The closed bore necessary for the method according to the invention and into which is introduced the joining element 3.4, is in this case a through-bore 4.4 through one of the outer layers 1.1 of part 1. This through-bore 4.4 is closed by a further element, e.g., by an inner layer 1.2 or optionally by the facing, outer layer 1.3, in such a way that between the through-bore 4.4 and the element closing it opens a cavity area 11.1 extending substantially at right angles to the bore axis or is produced by the pressure of the joining element 3.4 on the bore-closing element, e.g., by a corresponding deformation of ~~the~~ inner layer 1.2.

~~The~~ Joining element 3.4 is inserted in ~~the~~ bore 4.4 and is positioned by the bore-closing element (e.g. inner layer 1.2). ~~The~~ Joining element 3.4 is then pressed against the bore-closing element and simultaneously the plastics material is plasticized in the area of this element and is pressed into the cavity area 11.1, existing or produced between the outer layer 1.1 and the bore-closing element, so that a macroscopic anchor~~ing~~ 10 is obtained.

As has been stated, the method according to Fig. 8 is particularly suitable for lightweight construction~~al~~ applications where, in place of solid

material, use is made of thin, board-like material carried by a support structure (indicated by the two laths 20). The outer layers 1.1 and 1.3 are, e.g., thin solid wood boards or coated chipboards. The element closing ~~the~~ bore 4.4 can, e.g., be a plastic or metal inner layer 1.2 extending from a lath 20 to a neighbouring lath 20 or over the entire surface of the first layer, or can be a differently shaped element locally and specifically integrated for this purpose into ~~the~~ cavity 11.

~~The~~ Joining element 3.4 according to Fig. 8 is, e.g., suitable for ~~fixing~~ attaching fittings to lightweight structural components.

Thermoplastic materials for use in joining elements advantageously have a high mechanical strength, particularly a high tensile strength and a high modulus of elasticity. Polyamides, polycarbonates or polyester carbonates are particularly suitable. For increasing the strength, the plastics material of a joining element can, e.g., also contain glass or carbon fibres. Further thermoplastics materials suitable for use as joining elements are acrylonitrile-butadiene-styrene, styrene-acrylonitrile, polymethylmethacrylate, polyvinyl chloride, polyethylene, polypropylene and polystyrene.

~~An exemplified~~ A joining pin for joining two wooden parts, as shown in Fig. 2, e.g., has the form shown in Fig. 2 and is made entirely from acrylonitrile-butadiene-styrene. It has a smaller portion with a circular cross-section with a diameter of 8 mm and a larger portion having a circular cross-section with a diameter of 10 mm. It is 60 mm long and is centrally provided with the cross-sectional reduction. The ~~corresponding~~ mating bore is 40 mm deep and has the step positioned to correspond~~ing~~ to the cross-sectional reduction of the pin at a height of 30 mm. The pin is inserted in the bore and is pressed into it for 5 sec. with a pressing force of 2000N and ultrasonic excitation with an amplitude of approximately 44 µm. ~~Subsequently~~ Upon completion of the assembly, the outer pin end is flush with the wood surface.

ABSTRACT OF THE DISCLOSURE

A joining pin (3.2) with which ~~e.g. are to be joined together~~ two parts (1 and 2) made from a porous material, particularly wood or a woodlike material, are to be joined together, is anchored in the porous material at predetermined anchoring points (31, 33). For this purpose, a bore (4.2) with a closed inner end (41) is made in the parts (1 and 2). The shape of this bore (4.2) is so matched to the joining pin (3.2) that it can be introduced substantially without force expenditure into the bore and is positionable in a first position, ~~and that at~~ at least one predetermined anchoring point (31, 33) between the joining pin (3.2) and the wall of the bore (4.2) is formed when pressure is built up by pressing ~~if~~ the joining pin (3.2) ~~is pressed~~ with a pressing force (F) more deeply into the bore ~~in~~ to a second position. Energy is supplied in a planned manner to the joining pin (3.2), so that at the predetermined anchoring points (31, 33) the thermoplastic material of the joining pin (3.2) is plasticized. The locally plasticized plastic material is pressed by the local pressure into the porous material of the parts and forms local, macroscopic anchors ~~ings~~ (10, 20). The joining pin (3.2) is, e.g., made entirely from a thermoplastic material and the energy for plasticizing is supplied thereto by ultrasonic vibration.

(Fig. 2)

Docket No. 41-303-3

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) and 1.27(c) - SMALL BUSINESS CONCERN

I hereby declare that I am:
[ ] the owner of the small business concern identified below
[XX] an official of the small business concern identified below empowered to act for the concern.
Name of Concern: Creaholic S.A.
Address of Concern: Rue Molz 10, 2502 Biel, Switzerland

I hereby declare that the above-identified small business concern qualifies as a small business concern as identified in 13 CFR §§121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under Section 41(a) and (b) of title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention entitled METHOD FOR ANCHORING JOINING ELEMENTS IN MATERIAL HAVING PORES OR CAVITIES AND JOINING ELEMENTS FOR ANCHORING by Marcel Aeschlimann, Elmar Mock, Laurent Torriani and Heinz Koester described in

[ ] the specification filed herewith
[XX] application Ser. No. PCT/CH98/00109 filed internationally March 19, 1998

If the rights held by the above-identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed below* and no rights to the invention are held by any person who could not qualify as a small business concern under 37 CFR 1.9(d) or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).
*NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention, averring status as a small entity (37 CFR 1.27).

Full name:
Address:
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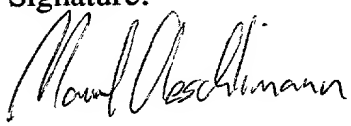
I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

Name of person signing: Marcel Aeschlimann
Title of Person other than Owner: Director
Address of Person Signing: Neuenburgstrasse 146, 2502 Biel, Switzerland
Signature: Date: 23-11-99



METHOD FOR ANCHORING JOINING ELEMENTS IN A MATERIAL HAVING PORES OR CAVITIES, AS WELL AS JOINING ELEMENTS FOR ANCHORING

The invention relates to a method according to the preamble of claim 1. The method is used for anchoring joining elements in a material having pores or cavities, particularly in wood or woodlike materials (e.g. chipboards). The invention also relates to joining elements for use in the method. The joining elements anchored according to the method of the invention are more particularly used for producing constructions constituted by different parts or for fixing fittings.

According to the prior art parts made from wood or woody materials are interconnected e.g. using joining elements in the form of nails or screws, in that they are driven through one of the parts to be joined into the other part to be joined. Screws and nails are generally made from metal and have in surface areas of one of the parts to be joined a head and are at least frictionally or positively anchored in another of the parts to be joined. These pin-like joining elements constitute in wooden structures metallic, often corrosive foreign bodies, which can be prejudicial to working after the joining of the parts and which represent heat transfer bridges in the finished structures.

It is also known to join parts made from fibrous materials, including wood and woodlike materials, to parts made from thermoplastics, in that the thermoplastic is plasticized at its surface facing the fibrous material part and the two surfaces are pressed onto one another. The plastic is thereby applied in plasticized form to the surface of the fibrous material or it is plasticized in the final position, e.g. by ultrasonic excitation. In all these methods a joint is formed at the interface between the plastic and the fibrous material in the sense of a microscopic self-closure in that the plasticized plastics material is pressed into surface unevennesses of the fibrous material. Such methods are e.g. described in FR-2455502, FR-1495999, DE-3828340 or EP-269476. According to WO-96/01377 the plastics part can also be a dowel, which joins together two wooden parts. The same principle forms the basis for known methods for joining parts made from wood or woodlike materials, in which between the parts to be joined is placed a layer of a thermoplastics material, e.g. a paint layer and the parts are then pressed together and subject to ultrasonic action

(JP-52127937, WO-96/01377).

In all the aforementioned methods synthetic material and fibrous material are joined together by surface adhesion resulting from microscopic self-closure and this occurs in the same way in conventional bonding or adhesion processes. The above methods have many of the same disadvantages as bonding methods, particularly their sensitivity to moisture and thermal stresses, in which the two joined together surfaces expand to varying extents and considerable shear forces arise, which weaken or even destroy the joint.

The problem of the invention is to provide a method for anchoring joining elements, e.g. joining pins, in parts made from a material having pores or cavities, particularly in parts made from wood or woodlike materials, said method being based on the aforementioned methods for joining plastic/synthetic material and wooden parts, but in which the disadvantages thereof are at least reduced, i.e. in particular provides anchorings, which are more stable under thermal and/or moisture stresses and loads. The method must be simple, but still adaptable in specific manner to joining elements with different functions and to different material types. The method must also be performable with known means and tools and at a limited cost.

This problem is solved by the method defined in the claims.

According to the method of the invention for an anchoring plasticized synthetic material is not only pressed into surface unevennesses as in the known methods, but instead into pores or cavities within the part in which the joining element is to be anchored, so that a macroscopic anchoring is formed. This macroscopic anchoring is based on the penetration of the plasticized synthetic material into microscopic pores of the material and to the formation of a type of composite comprising the original porous material and the synthetic material which has penetrated it or to macroscopic self-closure, which results from the fact that the plasticized synthetic material is pressed into macroscopic cavities.

According to the method of the invention in the part in which the joining

element is to be anchored an opening with a closed end, e.g. a bore (blind hole) is formed and then in said bore is positioned the joining element, which is wholly or partly made from a thermoplastic material.

The shapes of the bore and the joining element are so matched to one another that the joining element, without force expenditure, can be introduced into the bore up to a first position and that, if it is driven with the aid of a pressing force parallel to the bore axis from said first position towards the closed end of the bore into a second, final position, pressure builds up at at least one predetermined anchoring point between the joining element and the bore wall, whereas no pressure arises at other points.

Simultaneously with the pressing in of the joining element from its first into its second position in the bore or immediately prior thereto energy is supplied to the joining element in such a way that the plastics material is locally plasticized at the aforementioned, predetermined anchoring points, where the pressure is concentrated. Such a planned, local plasticizing can e.g. be achieved in that:

- the joining element is entirely made from a thermoplastic material or at least in areas of the predetermined anchoring points has at least surface areas made from a thermoplastic material and in that such a joining element is subject to ultrasonic or some other appropriate vibration action for the supply of energy, so that at the pressure concentration points (predetermined anchoring points) the greatest friction and therefore the maximum heat is produced and consequently the thermoplastic material is locally plasticized (related to joining methods such as ultrasonic, friction, vibration or orbital welding);

- in that the joining element, in areas of the predetermined anchoring points, has at least surface areas of a thermoplastic material, which is plasticizable at a lower temperature than the remaining materials of the joining element and in that such a joining element is heated by heat supply;

- in that the joining element, in areas of the predetermined anchoring

points, has at least surface areas of a thermoplastic material, in which are incorporated metal particles and in that such a joining element is inductively heated.

On its inside which, in the closed bore is directed towards the closed end of the bore, the joining element has at least one first, predetermined anchoring point. On its opposite outside, i.e. on the side projecting from the bore or positioned in the bore opening, the joining element has a thickening serving as a head or a means for fixing a further part or has further anchoring points spaced from the first anchoring point towards the outside. It is also conceivable to have pin-like joining elements with several predetermined anchoring points.

Whilst the joining element is pressed in the second, final position in the bore and energy is simultaneously supplied thereto, at the predetermined anchoring points where a high pressure occurs between the joining element and the bore wall, the joining element material is plasticized and as a result of the pressure at these points is pressed into the bore wall or into pores or cavities in the material, which is adjacent to the bore, whereas it remains unchanged at other points.

To ensure that the plasticized synthetic material is pressed by the pressure produced at the anchoring points into the bore wall, it must have a porosity or openings/cavities or the bore wall must be created in such a way that as a result of the pressure formed pores or cavities are produced in which the plasticized material can be pressed. Porous materials suitable for anchorings according to the method of the invention are in particular wood or woodlike materials, but also sandstone, ceramic materials, burnt brick or concrete, etc. Cavities suitable for producing anchorings according to the invention open substantially transversely to the bore axis and are in particular found in lightweight structural components.

The attainable depth of the anchoring of a synthetic material in a porous material is dependent on its structure (e.g. for wood on the density of the wood fibres), but also on the pressure applied and the locally available plasticized material quantity. As will be shown hereinafter, in solid wood

e.g. anchoring depths of 1 to 4 cm are readily attainable.

The desirable depth of the anchoring of the synthetic material in a porous material is dependent on the loadability of the material and can be controlled via the quantity of material to be pressed in and/or via the applied pressing force level. The shape of the anchoring can be substantially controlled by a corresponding matching of the bore shape and the joining element shape. Thus, using the method according to the invention it is possible to produce anchorings, which are specifically adapted to the character of the material (e.g. wood type, orientation of the graining or density gradient relative to the orientation of the bore, etc.) in which the anchoring is to be produced and to the function and loading to be absorbed by the joining element.

The most advantageous bore and joining element shapes for a specific application, as well as the pressing force level and the quantity of energy to be supplied to the joining element are to be established experimentally in each specific case.

The inventive method for anchoring joining elements in a part made from a porous material, particularly wood or a woodlike material, or a material having suitable cavities and different types of joining elements are described in greater detail hereinafter relative to the attached drawings, wherein show:

Fig. 1 — A specific method variant for anchoring a joining pin with a head in one wooden part for joining two wooden parts.

Fig. 2 — Another exemplified method variant for anchoring a joining pin in two wooden parts to be joined.

Figs. 3 to 5 — Three exemplified embodiments of the anchoring point in areas of the closed bore end.

Fig. 6 An example of a fitting, which is fixed with the aid of a plurality of joining pins anchored in a wooden part to said part.

Fig. 7 Another exemplified method variant for anchoring a joining element, which has an internal thread for fixing further parts.

Fig. 8 An example of an anchoring according to the invention in a lightweight component with cavities.

In all the drawings the joining elements, bores and anchorings are shown in section along the bore axis.

Fig. 1 shows as the first, exemplified variant of the inventive method an anchoring of a pin-like joining element with head (joining pin 3.1) in a first, wooden part 1 for joining said first part 1 to a second part 2.1, which is e.g. also made from wood.

In the vicinity of its inner end the joining pin 3.1 has a predetermined, first anchoring point 31 and at its outer end a head 32. The bore 4.1 which passes entirely through the part 2.1 and has in part 1 a closed end 41 is less deep than the joining pin 3.1 is long and has at its open end e.g. a widened depression for countersinking the head 32. The cross-section of the bore 4.1 is so matched to the cross-section of the joining pin 3.1, that without force expenditure the pin can be introduced into the bore up to the closed end 41 thereof. This is the first position of the joining pin 3.1 in the bore 4.1.

From the first position the joining pin 3.1 is pressed further into the bore 4.1 with a pressing force F oriented substantially parallel to the bore axis. The only point at which the pressing force F gives rise to a pressure between the joining pin 3.1 and the wall of the bore 4.1 is the area of the closed bore end 41. If in the above-described manner, by supplying energy to the joining pin it is ensured that during pressing in the material of the joining pin is only plasticized at this point, only at

this point is there an anchoring 10 of the joining pin in the part 1 to be joined.

In the drawing this anchoring 10 is shown as a synthetic material area, but in fact is constituted by an intimate mixture of wood fibres and synthetic material, which can be likened to a composite material and which can e.g. be of pinewood, whose graining is oriented parallel to the bore axis, where it has a depth of up to 2 cm.

The length of the joining pin 3.1, the depth of the bore 4.1, the force F and the quantity of energy to be supplied are so matched to one another that the anchoring fulfils the desired strength conditions and that the two parts are firmly fixed together between the joining pin head 32 and the anchoring 10.

The joining pin 3.1 of fig. 1 is anchored in the part 1 by the anchoring point 10, which is only possible in a part made from a porous material, particularly wood or a woodlike material, or, if the bore wall material has suitable cavities in the vicinity of the anchoring point or if the pressure exerted on the joining pin produces such openings in the bore wall.

Part 2.1 can also be made from wood or some other, non-porous material (metal, plastic). As shown in fig. 1, the head 32 can be a component of the joining pin. However, the head can also be placed on the joining pin after producing the anchoring, e.g. can be screwed into a thread provided in the joining pin. The head 32 can be in any random form and can e.g. also represent a fitting with a specific function.

An advantage of joining two parts in the manner shown in fig. 1 compared with other joining methods, in which plasticized materials are used as joining materials, is that in all cases it is possible to prevent plasticized material being pressed into the gap between the parts 1 and 2.1 to be joined resulting in the pressing apart thereof. This is prevented in that in the areas of such a gap no pressure is built up and the material of the joining pin is not plasticized in said area.

If the energy to be supplied to the joining pin is supplied in the form of ultrasonic waves, in the manner shown the joining pin 3.1 must be made from a thermoplastic material in the area of its inner end to be positioned, as shown, on the closed bore end 41. The remainder of the pin can be made from the same material or a different material.

If the energy to be supplied to the joining pin 3.1 is supplied in the form of heat, in the vicinity of the anchoring point it is constituted by a plastics material, which is plasticizable at a lower temperature than the material from which the joining pin is made in other areas. It is also conceivable in such a case for the joining pin to have a "core" of a heat conducting material, e.g. metal, by means of which core the heat to be supplied to the joining pin can be conducted against the anchoring point.

If the energy to be supplied to the joining pin is supplied inductively, the thermoplastic material of the predetermined anchoring point 31 contains incorporated metal particles.

Fig. 2 shows as a further exemplified variant of the inventive method an anchoring of a pin-like joining element (joining pin 3.2) in two parts 1 and 2.2 to be joined together and which are e.g. of wood, the joining pin 3.2 being anchored in both parts 1 and 2.2 (anchorings 10 and 20).

Like the joining pin 3.1 of fig. 1, the joining pin 3.2 has a predetermined, first anchoring point 31 at its inner end to be inserted in the bore. It also has a predetermined, second anchoring point 33, which is in the form of a step-like cross-sectional reduction and on the pin is positioned where it is located in the second part 2.2 to be joined.

The bore 4.2 has a cross-sectional reduction 42 corresponding to the cross-sectional reduction on the joining pin 3.2 and on it rests the joining pin in its first position. If the joining pin 3.2 is pressed by the pressing force F more deeply into the bore 4.2, pressure builds up not only in the vicinity of the closed end 41 of the bore 4.2, but also in the area of the cross-sectional reduction 42, is pressed through the plastics material plasticized at this point into the wall of the bore 4.2 and consequently

forms a second anchoring 20.

The bores 4.1 and 4.2 of figs. 1 and 2 advantageously have a circular cross-section. The joining pins 3.1 and 3.2 can also be circular. However, they can also have some other cross-section fitting into the corresponding bore. For example, in the vicinity of its smaller cross-section, the joining pin 3.2 can be circular and in the area of its larger cross-section can have an angular cross-section (e.g. square), only the areas of the edges resting on the step 42.

In both figs. 1 and 2 the closed end 41 of the bore is shown flat and the joining pin in its first position rests with a flat face in the bore. With such a shaping of the bore and joining pin, on pressing in the pin, a substantially uniform pressure builds up over the entire face. The plasticized material is mainly driven into the wood parallel to the longitudinal axis of the joining pin, so that the cross-section of the anchoring 10 is only slightly larger than the cross-section of the joining pin.

Such a construction of the predetermined, first anchoring point is advantageous for applications in which, in the vicinity of the first anchoring 10, the wood graining is oriented parallel to the bore axis and the wood of part 1 splits in the case of a limited displacement. Roughly the same effect is obtainable with a pin end tapered to a point, which in its first position rests on a roughly identically tapering bore end.

Figs. 3 to 5 show further embodiments advantageous for specific applications of predetermined, first anchoring points 31 on e.g. pin-like joining elements 3 and cooperating, closed ends 41 of bores 4, which particularly in the case of ultrasonic application leads to different anchorings 10.

Fig. 3 shows in two variants one end of a joining pin 3, which is placed in a closed end of a bore 4. In both cases the pin end is pointed and specifically more sharply than the bore end. As a result the pressure arising on pressing the joining pin 3 into the bore 4 is centrally concentrated, so that the material is to an even greater extent pressed parallel to the pin axis into the part 1, so that also here the resulting anchoring

10 extends more in the axial direction than at right angles thereto. The strength of such an anchoring is more particularly due to an enlargement of the shear-loaded surfaces in the wood.

Fig. 4 shows one end of a pin 3 having a concave shape. On pressing this pin into a bore with a flat or pointed, closed end, the pressure mainly builds up at radial positions, which gives rise to an anchoring 10, which extends to a greater extent transversely to the pin axis. Such an anchoring is more particularly suitable for a part 1, where the graining is at right angles to the pin axis, or for an anchoring in a chipboard, whose surface is at right angles to the pin axis. The strength of such an anchoring results more particularly from the self-closure obtained between the wooden part and the joining pin.

Fig. 5 shows another embodiment of the predetermined, first anchoring point 31 on a joining pin 3 and a corresponding bore end 41. It is a first anchoring point having substantially the same construction as the second anchoring point of fig. 2. Bore 4 has a step-like cross-sectional reduction 43, on which is mounted the pin in its first position. If this joining pin is pressed into the bore, more particularly a pressure is built up radially in the vicinity of the bore end and the plasticized material is pressed into the wood, more particularly transversely to the pin axis.

Fig. 6 shows a part 5 made from a random material, which is fixed to a part 1 with the aid of pin-like joining elements 3, which are anchored in said part 1 e.g. made from wood and in accordance with the method of the invention. The part 5 is a fitting (e.g. a hinge part), e.g. made from plastic. The two joining pins 3 are shaped onto the part 5 or are joined thereto in some other appropriate way and are driven in the described way into bores of part 1 and anchored therein. Here again, as mentioned in conjunction with fig. 1 concerning a joining pin head, the part 5 can have a random shape and, even after producing the anchoring, can be appropriately mounted on the joining pin or pins 3.

Fig. 7 shows the production of a connection of a wooden part 1 with a fitting part 6, e.g. made from metal, by means of an inventive anchoring of

a joining element 3.3 in part 1 and the fixing of the fitting part 6 to the anchored joining element 3.3. The joining element 3.3 has a two-step, first anchoring point 31 and is introduced into a bore 4.3 with a step-like, narrowing base. On pressing the joining element into the bore and during the simultaneous plasticizing of the anchoring point 31, bore 4.3 and joining element 3.3 act as explained in conjunction with fig. 4. A corresponding "two-step" anchoring 10 is formed.

The joining element 3.3 of fig. 7 has at its outside, facing the predetermined anchoring point, as the means for fixing a further part an internal thread 34, into which is screwed the fitting part 6 after anchoring the joining element 3.3 in part 1.

Fig. 8 shows the result of a further, exemplified embodiment of the inventive method, namely an anchoring of a joining element 3.4 in a part 1, which is a lightweight constructional component with cavities 11. The closed bore necessary for the method according to the invention and into which is introduced the joining element 3.4, is in this case a through bore 4.4 through one of the outer layers 1.1 of part 1. This through bore 4.4 is closed by a further element, e.g. by an inner layer 1.2 or optionally by the facing, outer layer 1.3, in such a way that between the through bore 4.4 and the element closing it opens a cavity area 11.1 extending substantially at right angles to the bore axis or is produced by the pressure of the joining element 3.4 on the bore-closing element, e.g. by a corresponding deformation of the inner layer 1.2.

The joining element 3.4 is inserted in the bore 4.4 and is positioned by the bore-closing element (e.g. inner layer 1.2). The joining element 3.4 is then pressed against the bore-closing element and simultaneously the plastics material is plasticized in the area of this element and is pressed into the cavity area 11.1, existing or produced between the outer layer 1.1 and the bore-closing element, so that a macroscopic anchoring 10 is obtained.

As has been stated, the method according to fig. 8 is particularly suitable for lightweight constructional applications where, in place of solid

material, use is made of thin, board-like material carried by a support structure (indicated by the two laths 20). The outer layers 1.1 and 1.3 are e.g. thin solid wood boards or coated chipboards. The element closing the bore 4.4 can e.g. be a plastic or metal inner layer 1.2 extending from a lath 20 to a neighbouring lath 20 or over the entire surface of the first layer, or can be a differently shaped element locally and specifically integrated for this purpose into the cavity 11.

The joining element 3.4 according to fig. 8 is e.g. suitable for fixing fittings to lightweight structural components.

Thermoplastic materials for use in joining elements advantageously have a high mechanical strength, particularly a high tensile strength and a high modulus of elasticity. Polyamides, polycarbonates or polyester carbonates are particularly suitable. For increasing the strength the plastics material of a joining element can e.g. also contain glass or carbon fibres. Further thermoplastics suitable for joining elements are acrylonitrile-butadiene-styrene, styrene-acrylonitrile, polymethylmethacrylate, polyvinyl chloride, polyethylene, polypropylene and polystyrene.

An exemplified joining pin for joining two wooden parts, as shown in fig. 2, e.g. has the form shown in fig. 2 and is made entirely from acrylonitrile-butadiene-styrene. It has a smaller, circular cross-section with a diameter of 8 mm and a larger, circular cross-section with a diameter of 10 mm. It is 60 mm long and is centrally provided with the cross-sectional reduction. The corresponding bore is 40 mm deep and has the step corresponding to the cross-sectional reduction of the pin at a height of 30 mm. The pin is inserted in the bore and is pressed into it for 5 sec. with a pressing force of 2000N and ultrasonic excitation with an amplitude of approximately 44 µm. Subsequently the pin end is flush with the wood surface.

CLAIMS

1. Method for anchoring a joining element (3, 3.1 to 3.4) in a part (1), which is made from a porous material having cavities (11.1) or in which cavities can be produced by pressure, the joining element being introduced into a bore (4, 4.1 to 4.4) with an inner, closed end (41), characterized in that the joining element (3, 3.1 to 3.4) is positioned in the bore in a first position and that the joining element is then pressed more deeply into the bore from the first position into a second position with a pressing force (F) oriented substantially parallel to the bore axis, the joining element (3, 3.1 to 3.4) and the bore (4, 4.1 to 4.4) being so matched to one another that the joining element can be positioned in the first position substantially without force expenditure and that on pressing into the second position pressure is built up at at least one predetermined anchoring point (31, 33) between the joining element (3, 3.1 to 3.4) and the wall of the bore (4, 4.1 to 4.4), the joining element being made from a thermoplastic material at least in the vicinity of the predetermined anchoring point (31, 33) and during the pressing of the joining element into the second position energy is supplied to the joining element in such a way that the thermoplastic material is plasticized in the vicinity of the at least one predetermined anchoring point (31, 33) and by the pressure is pressed into the pores or cavities of the part (1) and a macroscopic anchoring (10, 20) is formed.

2. Method according to claim 1, characterized in that the at least one predetermined anchoring point (31) is provided in the vicinity of the closed bore end (41) in that the joining element (3, 3.1 to 3.4) and the bore (4, 4.1 to 4.4) are so matched to one another that in its first position the joining element extends up to the closed end of the bore or rests on a cross-sectional reduction (43) of the bore in the vicinity of the closed end (41).

3. Method according to claim 2, characterized in that the joining element is a joining pin (3.2) for joining the first part (1) to a second part (2.2) also made from a porous material or provided with cavities, that the bore (4.2) passes through the second part (2.2) and that in the second part

(2.2) is provided a further anchoring point (33), so that the bore (4.2) in the second part (2.2) has a step-like cross-sectional reduction (42) and the joining pin (3.2) has a shoulder substantially corresponding to the cross-sectional reduction (42) with which it rests in its first position on the step-like cross-sectional reduction (42).

4. Method according to claim 2, characterized in that the joining element is a joining pin (3.1) and that for joining the first part (1) to a second part (2.1) the bore (4.1) passes through the second part (2.1) and the joining pin (3.1) has a head-like thickening.

5. Method according to claim 2, characterized in that for joining a first part (5, 6) to the first part (1), the second part (5, 6) is produced in one piece with the joining element (3) or is fixed before or after anchoring to the joining element (3.3).

6. Method according to one of the claims 1 to 5, characterized in that the joining element (3, 3.1 to 3.4) is ultrasonically excited for supplying energy.

7. Method according to one of the claims 1 to 5, characterized in that the joining element (3, 3.1 to 3.4) is made entirely from a thermoplastic material, which can be plasticized at lower temperatures in the vicinity of the at least one anchoring point (31, 32) than the remainder of the joining element and that energy in the form of heat is supplied to the joining element (3, 3.1 to 3.4).

8. Method according to one of the claims 1 to 5, characterized in that, in the vicinity of the at least one anchoring point (31, 33), the joining element (3, 3.1 to 3.4) has surface areas of a thermoplastic material with metal particles incorporated therein and that the joining element (3, 3.1 to 3.4) is inductively heated for supplying energy.

9. Method according to one of the claims 1 to 8, characterized in that the part (1, 2.2) in which the joining element (3, 3.1 to 3.3) is anchored is made from wood or a woodlike material.

10. Method according to one of the claims 1 to 8, characterized in that the part (1, 2) in which the joining element (3, 3.1 to 3.3) is anchored comprises sandstone, a porous, ceramic material, burnt brick or concrete.

11. Method according to one of the claims 1 to 8, characterized in that the part (1) in which the joining element (3.4) is anchored is a lightweight structural component with cavities (11) and that the bore (4.4) is a through bore through an outer layer (1.1), which is so closed by an inner layer (1.2) or by an element located in the cavity (11) that in the vicinity of the closed end of the bore (4.4) there are essentially radial openings in the cavity areas (11.1) or these are produced by the pressing force.

12. Joining element (3, 3.1 to 3.4) for use in a method according to one of the claims 1 to 11, said joining element having an inside to be directed against the closed end of the bore (4, 4.1 to 4.4) and an outside facing it, characterized in that on its inside the joining element (3, 3.1 to 3.4) has a first, predetermined anchoring point (31) with at least surface areas made from a thermoplastic material and a second anchoring point (33), spaced from the first anchoring point, with respect to the outside, or on said outside a head-like thickening (32) or means (34) for fixing a further part (6).

13. Joining element according to claim 12, characterized in that it is pin-like and has a second anchoring point (33) in the form of a shoulder.

14. Joining element according to claim 12, characterized in that it has an internal thread (34) as a means for fixing a further part (6).

15. Joining element according to one of the claims 12 to 14, characterized in that it is made entirely from thermoplastic material.

16. Joining element according to claim 15, characterized in that, in the vicinity of the predetermined anchoring points (31, 33), the thermoplastic material is plasticizable at a lower temperature than the thermoplastic material in the other areas of the joining element.

17. Joining element according to one of the claims 12 to 14, characterized in that it comprises a thermosetting material and at the predetermined anchoring points (31, 33) has surface areas of a thermoplastic material.

18. Joining element according to one of the claims 12 to 14, characterized in that in the thermoplastic material it has metal particles incorporated into the vicinity of the predetermined anchoring points.

19. Joining element according to one of the claims 12 to 18, characterized in that it is pin-like and tapers to a point on its inside, or has a flat or concave face.

20. Joining element according to one of the claims 12 to 19, characterized in that the thermoplastic material is a polyamide, a polycarbonate or a polyester carbonate or acrylonitrile-butadiene-styrene, styrene-acrylonitrile, polymethylmethacrylate, polyvinyl chloride, polyethylene, polypropylene or polystyrene.

21. Use of the method according to one of the claims 1 to 11 and a joining element according to one of the claims 12 to 20 for joining the individual parts of solid wood shutters or window frames.

22. Use of the method according to one of the claims 1 to 11 and a joining element according to one of the claims 12 to 20 for fixing fittings to chipboards or lightweight structural components.

ABSTRACT OF THE DISCLOSURE

A joining pin (3.2) with which e.g. are to be joined together two parts (1 and 2) made from a porous material, particularly wood or a woodlike material, is anchored in the porous material at predetermined anchoring points (31, 33). For this purpose a bore (4.2) with a closed end (41) is made in the parts (1 and 2). The shape of this bore (4.2) is so matched to the joining pin (3.2) that it can be introduced substantially without force expenditure into the bore and is positionable in a first position and that at at least one predetermined anchoring point (31, 33) between the joining pin (3.2) and the wall of the bore (4.2) pressure is built up if the joining pin (3.2) is pressed with a pressing force (F) more deeply into the bore in a second position. Energy is supplied in planned manner to the joining pin (3.2), so that at the predetermined anchoring points (31, 33) the thermoplastic material of the joining pin (3.2) is plasticized. The locally plasticized plastic material is pressed by the local pressure into the porous material of the parts and forms local, macroscopic anchorings (10, 20). The joining pin (3.2) is e.g. made entirely from a thermoplastic material and the energy for plasticizing is supplied thereto by ultrasonic vibration.

(Fig. 2)

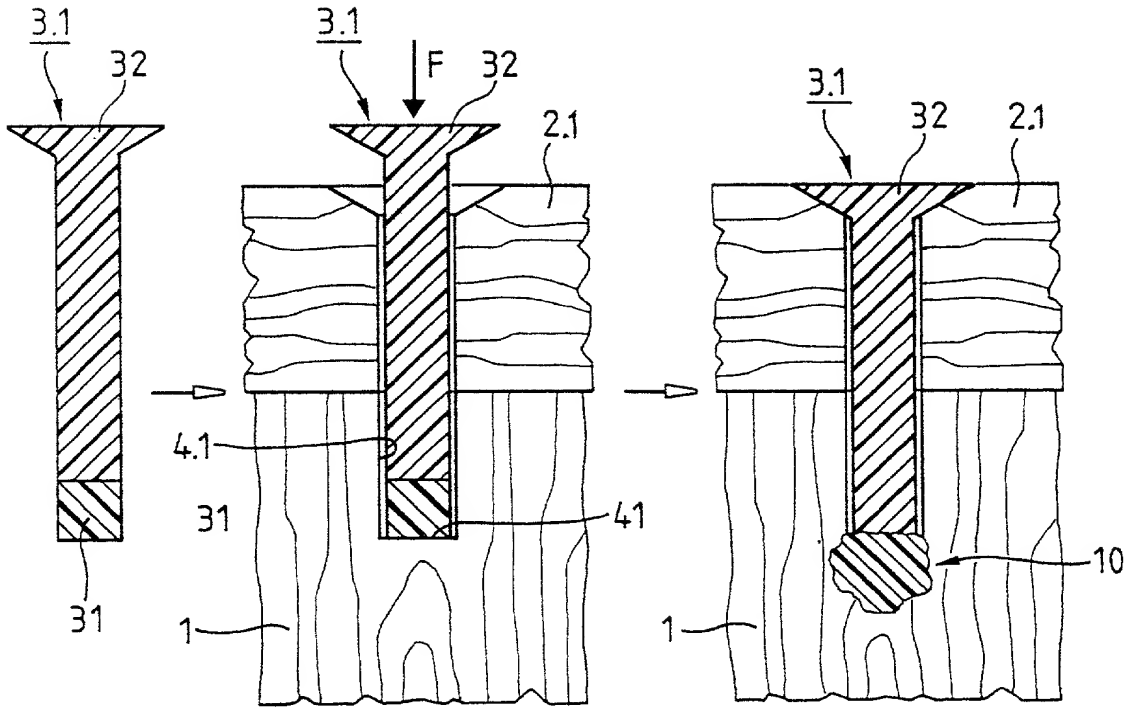


FIG.1

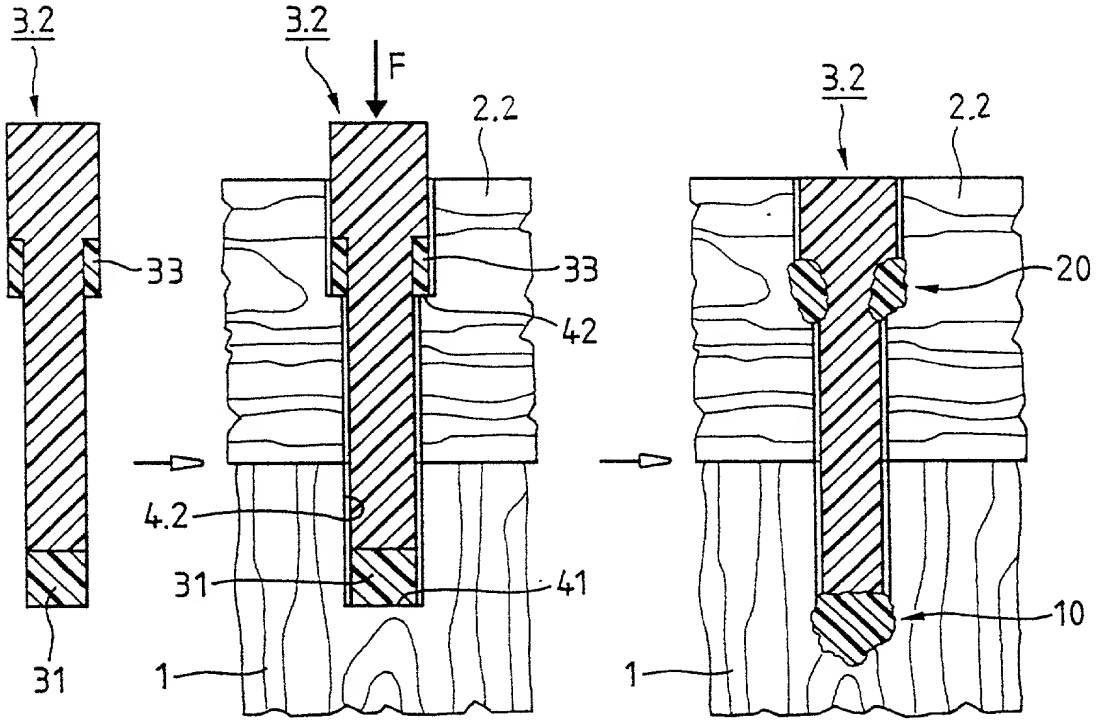


FIG.2

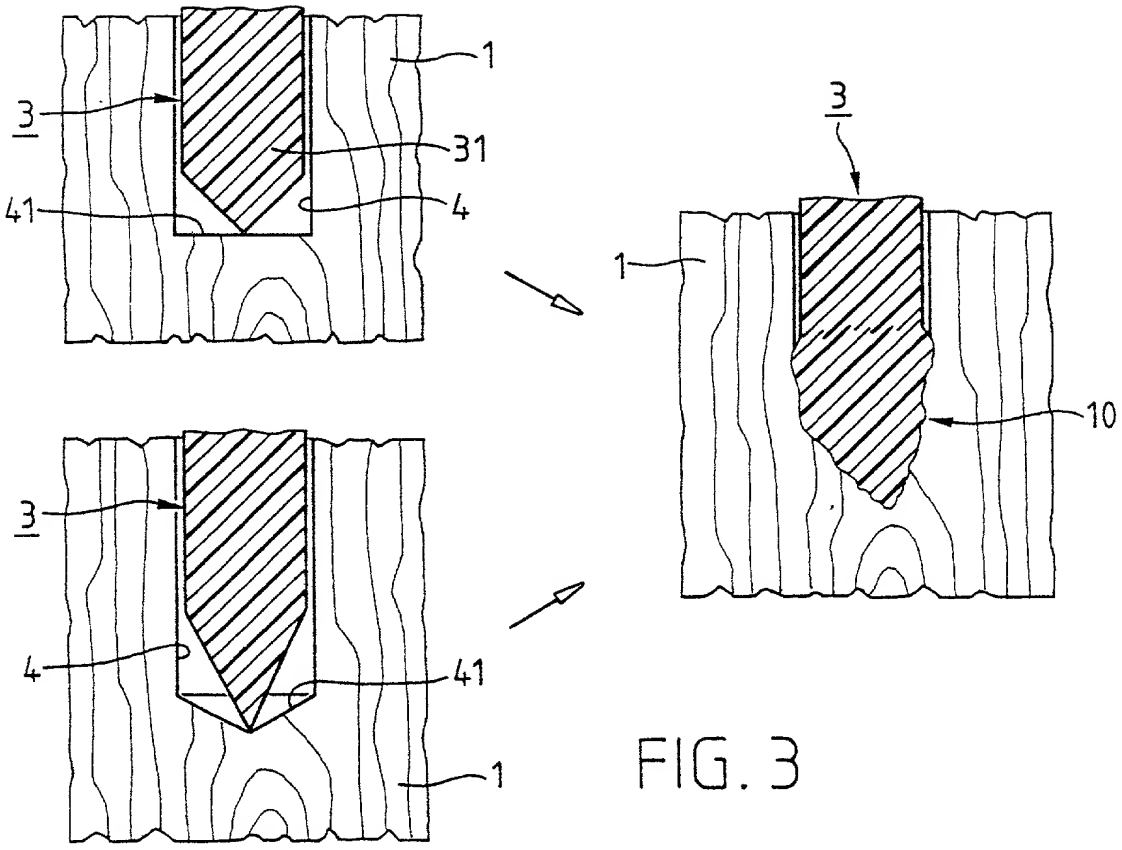


FIG. 3

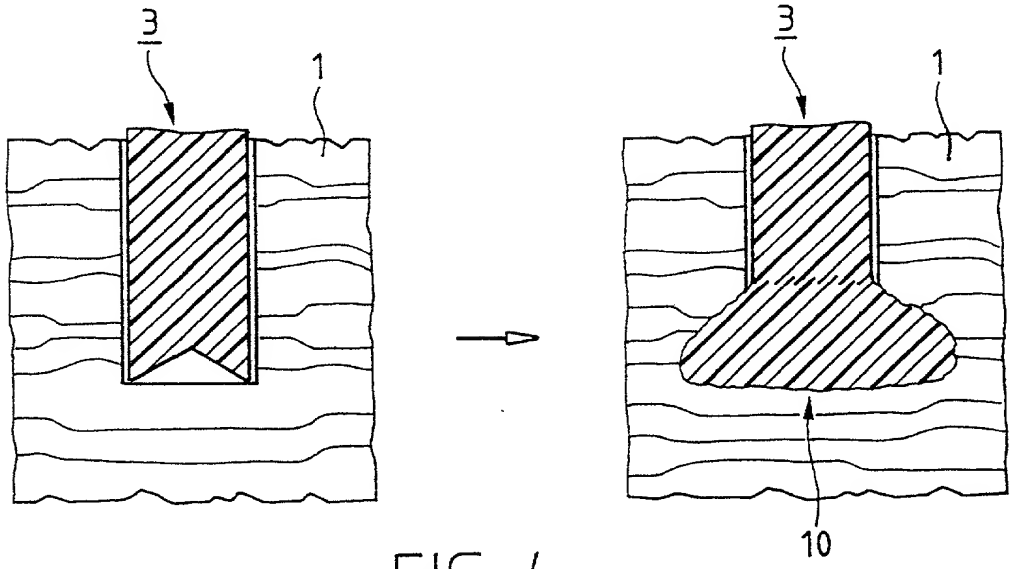


FIG. 4

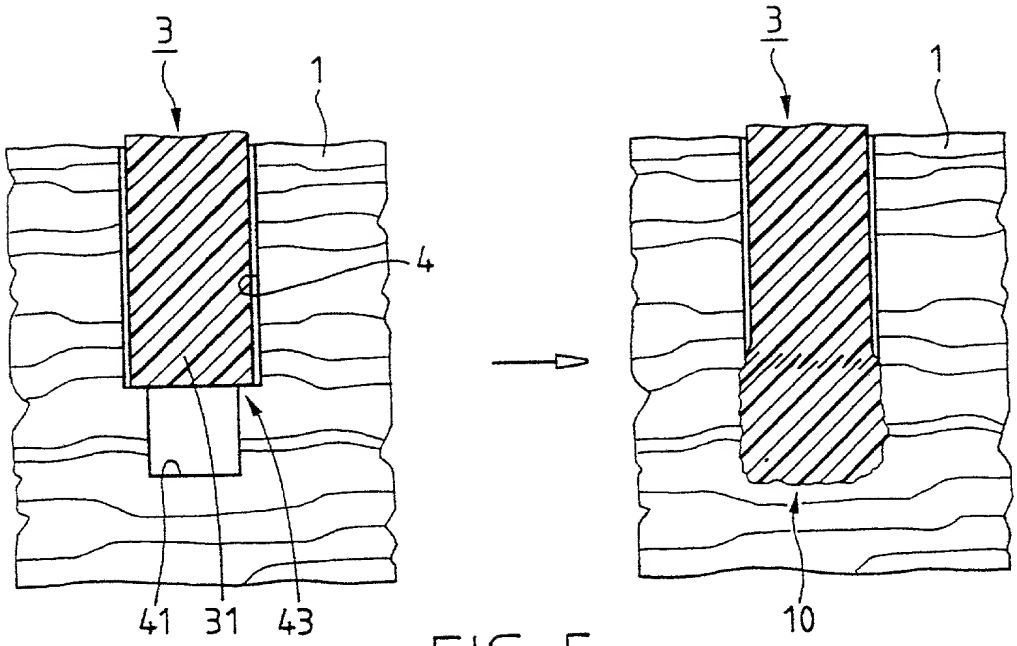


FIG. 5

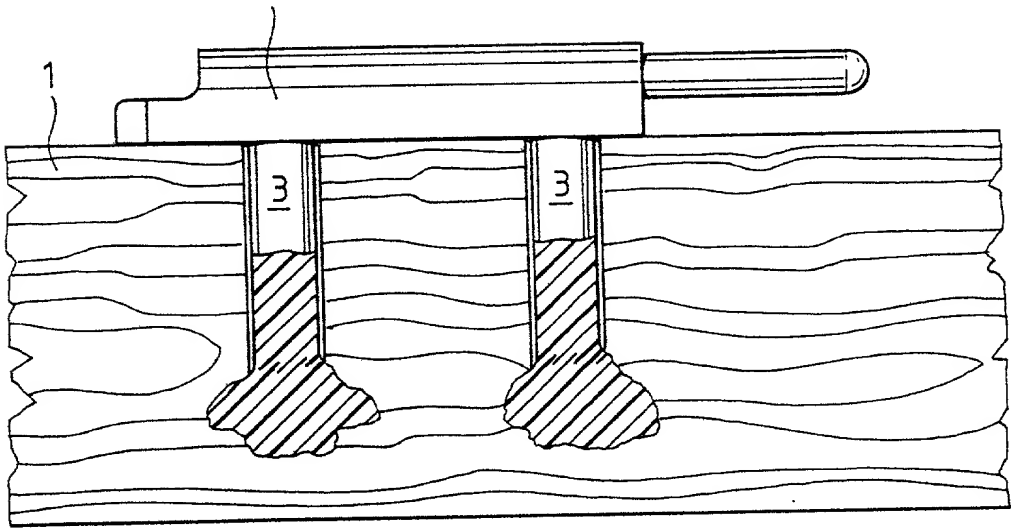
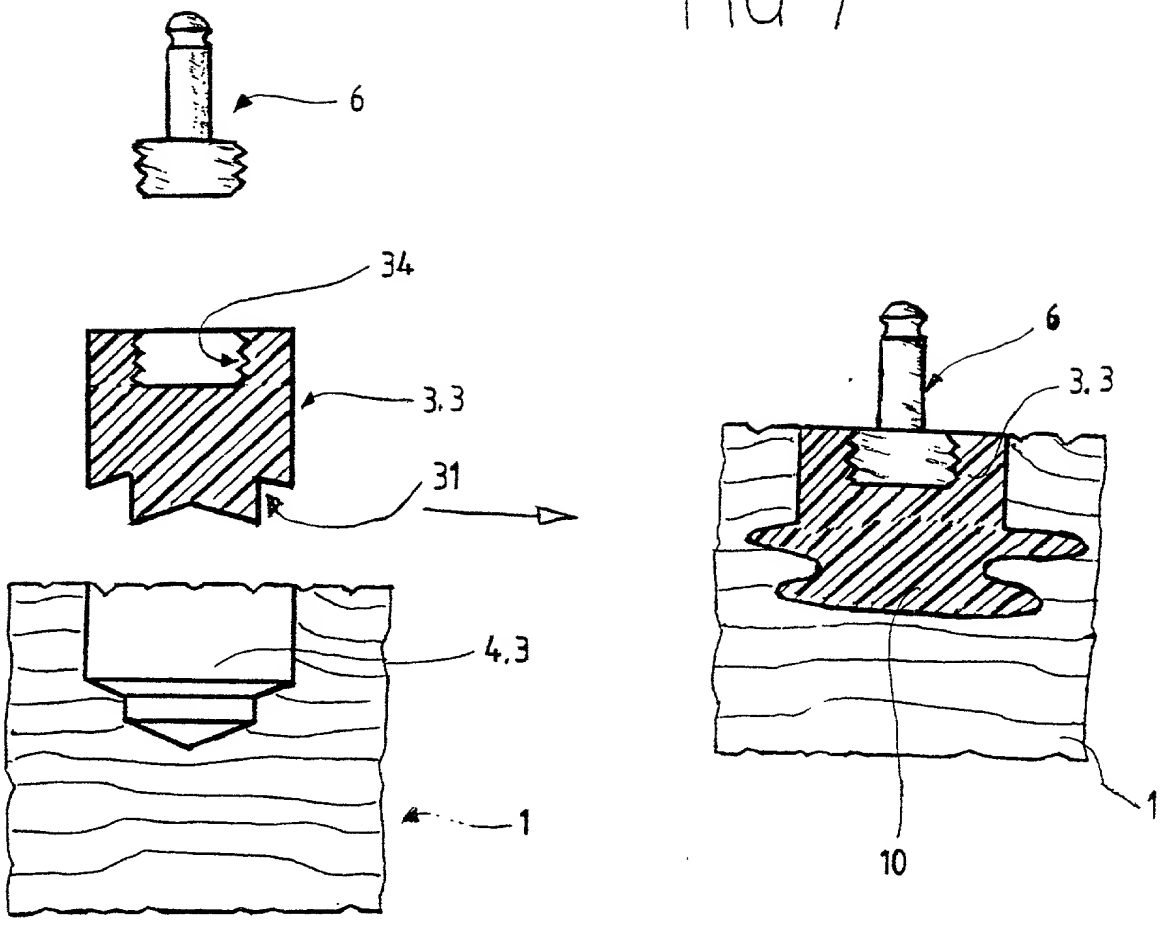


FIG. 6

FIG 7



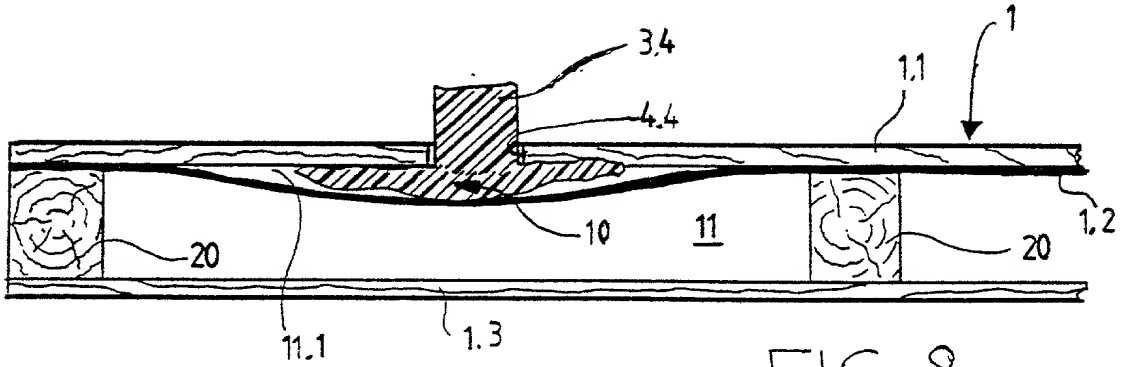


FIG 8

P1203 CIP

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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☐ Declaration Submitted with Initial Filing OR ☒ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	41-303-3
First Named Inventor	Aeschlimann, Marcel
COMPLETE IF KNOWN	
Application Number	09/381526
Filing Date	
Group Art Unit	
Examiner Name	

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD FOR ANCHORING JOINING ELEMENTS IN MATERIAL HAVING PORES OR CAVITIES AND JOINING ELEMENTS FOR ANCHORING

(Title of the Invention)

the specification of which

☐ is attached hereto

OR

☒ was filed on (MM/DD/YYYY) March 19, 1998 as United States Application Number or PCT International Application Number PCT/CH98/00109 and was amended on (MM/DD/YYYY) _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
679/97	Switzerland	March 21, 1997	☐	☐	☒
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date (MM/DD/YYYY)

☐ Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

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DECLARATION — Utility or Design Patent Application

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: ☐ Customer Number [ ] → Place Customer Number Bar Code Label here

OR

☒ Registered practitioner(s) name/registration number listed below

Name	Registration Number	Name	Registration Number
Walter C. Farley	22 624		
David E. Spaw	34 732		

☐ Additional registered practitioner(s) named on supplemental Registered Practitioner Information sheet PTO/SB/02C attached hereto.

Direct all correspondence to: ☒ Customer Number or Bar Code Label 000805 OR ☐ Correspondence address below

Name	Walter C. Farley				
Address	P.O. Box 329				
Address					
City	Harpswell	State	ME	ZIP	04079
Country	USA	Telephone	(207) 833-6793	Fax	(207) 833-7831

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor: ☐ A petition has been filed for this unsigned inventor

Given Name (first and middle [if any])	Family Name or Surname
00 Marcel	Aeschlimann

Inventor's Signature	X Marcel Aeschlimann					Date	X 8. März 2000
Residence: City	Biel	State		Country	Switzerland	Citizenship	CH
Post Office Address	Neuenbergstrasse 146 CHX						
Post Office Address							
City	Biel	State		ZIP	2502	Country	Switzerland

☒ Additional inventors are being named on the 1 supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto

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DECLARATION

ADDITIONAL INVENTOR(S)
Supplemental Sheet
Page 1 of 1

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor						
Given Name (first and middle [if any])			Family Name or Surname				
Elmar			Mock				
Inventor's Signature	X Elmar Mock					**Date**	X 10.3.00
Residence: City	Biel	**State**		**Country**	Switzerland	**Citizenship**	CH
Post Office Address	Jakobstrasse 33 CHX						
Post Office Address							
City	Biel	**State**		**ZIP**	2504	**Country**	Switzerland

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor						
Given Name (first and middle [if any])			Family Name or Surname				
Laurent			Torriani				
Inventor's Signature	X Laurent Torriani					**Date**	X 14.3.00
Residence: City	Biel	**State**		**Country**	Switzerland	**Citizenship**	CH
Post Office Address	Burggasse 13 CHX						
Post Office Address							
City	Biel	**State**		**ZIP**	2502	**Country**	Switzerland

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor						
Given Name (first and middle [if any])			Family Name or Surname				
Heinz			Koester				
Inventor's Signature	X Heinz Köst					**Date**	X 24.03.2000
Residence: City	Stefankirchen	**State**		**Country**	Germany	**Citizenship**	DE
Post Office Address	Walderringerstrasse 320 DEX						
Post Office Address							
City	Stefankirchen	**State**		**ZIP**	83071	**Country**	Germany

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